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Title:
Maritime navigation and radiocommunication equipment and systems-Integrated navigation systems - Operational and performance requirements, methods of testing and required test results

(Titre) :

Introductory note

IEC 61924 Ed 1 Standard has been developed by IEC TC80 WG 10 to clarify the IMO Resolution MSC 86(70) ANNEX 3 Recommendation on Performance Standards for an Integrated Navigation System (INS).

This Standard provides adequate requirements, methods of tests and required test results to facilitate Type Approval of such equipment

This CD is the second CD to be circulated.

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Clause

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS - INTEGRATED NAVIGATION SYSTEMS -

Operational and performance requirements, methods of testing and required test result

FOREWORD

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FDIS	Report on voting
XX/XX/FDIS	XX/XX/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until _____. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

INTRODUCTION

This IEC 61924 Ed 1 Standard has been developed by IEC TC80 WG 10 to clarify the IMO Resolution MSC 86(70) ANNEX 3 Recommendation on Performance Standards for an Integrated Navigation System (INS). This Standard provides adequate requirements, methods of tests and required test results to facilitate Type Approval.

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS - INTEGRATED NAVIGATION SYSTEMS -

Operational and performance requirements, methods of testing and required test result

1 Scope

This International Standard:

a) Specifies the minimum requirements for the design, manufacture, integration, methods of testing and required test results for an integrated navigation system (INS) to comply with the International Maritime Organisation (IMO) requirements of Resolutions MSC 86(70) (See annex C).

b) Also includes the requirements of IMO Resolution A.694 (17) - General requirements – to which IEC 60945 is associated. When a requirement in this standard is different from IEC 60945, the requirement in this standard shall take precedence.

c) Is applicable to an INS, that is any combination of navigational aids that provides functions beyond the general intent defined in the respective performance standards adopted by the Organisation for individual equipment (MSC 86(70), 2.1), i.e. if the functions provided by combining equipment are not included in or are not in the general intent of an IMO performance standard[1] of any individual equipment, then such combined equipment is an INS to which this international standard applies.

1.1 Mode and situation awareness

The INS supports mode and situation awareness. (MSC 86(70), 1.2) within the scope of functions provided by the relevant category of INS (A), (B), or (C).

1.2 Purpose

The purpose of this International Standard is to support proper and safe integration of navigational equipment and information. (MSC 86(70), 2.2).

1.3 Equipment required

The INS consists of the equipment that provides the functions going beyond the general intent (see 1.1c above) and the additional equipment required to meet this International Standard. The sensors and actuators required only for the input and output of data or commands and not providing other functions specified in this standard are not part of the INS.

1.4 Categories of INS

This International Standard defines three categories of INS's:

1.4.1 INS(A)

INS(A) for systems that provide the minimum functional requirements of the INS, including a consistent common reference system. (MSC 86(70), 2.3.1). INS (A) is any INS for which the categories of INS B and INS C, as per 1.4.2 and 1.4.3 respectively, do not apply.

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[1] Specifically an IMO standard or in case of doubt, other supplementary IMO documents or appropriate IEC/ISO standards where the general intent may be clarified by the minimum requirements. (For guidance see also annex A.)

1.4.2 INS(B)

INS (B) for systems that, in addition to the functional requirements of INS(A), provide the information needed for decision support in avoiding hazards.(MSC 86(70) 2.3.2)

An INS (B) is any INS that includes a (geo-) graphical display for decision support in avoiding hazards, such as a Radar, Radar Plotting Aid or ECDIS, if:

- the additionally displayed geographical information, resulting from the combination of navigational aids, goes beyond the general intent as defined in the respective performance standard
- it does not include automatic control functions of heading, track or speed.

1.4.3 INS(C)

INS (C) for systems that, in addition to the functional requirements of INS (B), provide the automatic control functions of heading, track or speed (MSC 86(70).

Combinations of navigational aids that include heading, track, or speed control systems shall comply with the requirements of this International Standard for INS (C) if the heading, track or speed control system automatically (without operator confirmation of each individual value at the control system) accepts inputs of heading, course, or speed commands, or changes thereof.

1.5 Conflicts

This International Standard aims to resolve conflicts that may occur from the differences in the requirements of the relevant IMO Performance Standards for individual navigational aids when forming part of the INS. (see also 4.3.1)

1.6 Passage execution

The function of passage execution in an Integrated Bridge system (IBS), as defined by IMO in Resolution MSC64(67) annex 1 – Recommendation on performance standards for Integrated Bridge Systems (IBS) and related IEC 61209, *may be performed by an INS* which should at least be an INS(B). (MSC 86(70), 1.5).

Note: All text of this standard whose meaning is identical to IMO SOLAS Ch. V, Resolutions A.694(17), as detailed in IEC 60945, and MSC 86(70) annex 3, is written in *italics* and is followed by the Resolution and paragraph numbers indicated in brackets at the end of the relevant paragraph e.g. A.694(17) 4.2.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60092-101 (1994-10). Electrical installations in ships - Part 1: Definitions and general requirements.

IEC 60812 (FMEA).

IEC 60872 (RP)

IEC 60936 series (radar).

IEC 60945(Ed 4) (General requirements)

IEC 60533 (1999-11) (Electromagnetic compatibility)

IEC 61162 series (Interfaces).

IEC 61209 (1997) (IBS)

IEC 61508 (Safety Systems).

IEC 61996 (VDR)

IEC 62065 (Track control systems)

IMO International Convention for the Safety of Life at Sea, 1974 (SOLAS 1974), as amended; and Protocol of 1978 relating to the International Convention for the Safety of Life at Sea, 1974 (SOLAS Protocol 1973/78), as amended.

IMO A.529(13) (Accuracy standards for navigation)

IMO A.815(19) (World-wide radionavigation system)

IMO A.694(17) (General requirements)

IMO A.817(19) (ECDIS)

IMOMSC.64 (67) (ECDIS)

IMO A.830(19) (Code on Alarms and Indicators)

IMO MSC 86(70), ANNEX 3 (INS)

IMO S/N C 217 (display of AIS target information)

ISO 3791 (1976) (Keyboard layouts for numeric applications)

ISO 8468 (Ship's bridge layout)

ISO 9000-3 (1991) (Quality of development, supply and maintenance of software)

ISO 9001 (1993) (Quality of design/development, production, installation and servicing)

ISO 9002 (1993) (Quality assurance in production and installation)

ISO 11674 (Heading control systems)

3 Definitions and abbreviations

3.1 Definitions

For the purpose of this standard the following definitions, apply: (MSC 86(70), 3). Other definitions not included in the IMO Resolution MSC 86(70), 3) have been added.

3.1.1
Added value
The functionality and information, that are provided by the INS, in addition to the requirements of the performance standard for the individual equipment.

3.1.2
Accuracy
The degree of conformance between the estimated or measured parameter value at a given time and its true parameter value at that time.

3.1.3
Automatic control system
A control system that may include a heading, track or speed control system. (MSC 86(70), 3.1).

3.1.4
Configuration in use
Sub-systems currently in use by the INS

3.1.5
confirmable command
a command readily prepared by the system for confirmation by the operator. Typically used for systems that can automatically prepare for the change of a control mode, in which case operator confirmation is required before execution

3.1.6
consistent common reference system (CCRS)
A sub-system or function of an INS for acquisition, processing, storage and distribution of data and information providing identical and obligatory reference to sub-systems within an INS. (MSC 86(70) 3.2). The CCRS is the means to ensure that all parts of the INS use the same source and values for a specific type of system data and essential information, e.g. ownship position, speed through water, heading, time, etc.

3.1.7
cross track distance (same as "Off track distance")
the distance between the present ship's position and the actual section of the selected route (or TRACK), measured perpendicular to the line connecting the last (or "FROM") waypoint and the next (or "TO") waypoint). The term is typically used in systems that do not include automatic track control functions. (see also "Cross track error")

3.1.8
cross track error (same as "Off track error")
The distance between the present ship's position and the actual section of the selected TRACK (or route), measured perpendicular to the line connecting the "FROM" (or last) waypoint and the "TO" (or next) waypoint). The term is typically used in systems that include automatic track control functions. (see also "Cross track distance")

3.1.9
entry field
an entry field is a location on a display for the input of data by the operator. The requested information is usually alphanumeric

3.1.10
Essential information
Information to be available for display as required for the relevant INS category and designated as such within this standard

3.1.11
Functionality
Ability to perform an intended function. The activity of performing a function normally employs a system of displays, controls and instrumentation

3.1.12
Hazards
Objects, potentially leading to grounding or collision, that may be detected by a sensor, reported by communication devices, retrieved from a database or manually input and which are available to the INS

3.1.13
Integrated navigation system
A combination of systems or functions of navigational aids *that are interconnected to increase safe and efficient navigation when used by suitably qualified personnel.* (MSC 86(70), 3.3)

3.1.14
Integrity
The property of information as being accurate, valid and uncorrupted with regard to specified requirements and verified by comparing data from more than one independent source. The integrity monitoring function includes the *ability of the system to provide the user with information within the specified accuracy in a timely, complete and unambiguous manner, and alarms and indications within a specified time when the system should be used with caution or not at all*. (MSC 86(70), 3.4.

3.1.15
Latency
Time interval between an event and its result, including time for reception, processing, transmission and display

3.1.16
Leg
The geographically defined line connecting two waypoints

3.1.17
Manufacturer
The manufacturer is the organisation responsible for the production of all or some of the parts of the INS, including the responsibility that these parts meet their individual international standards. A manufacturer may also be the system integrator

3.1.18
Mode
The actual setting of a group of parameters determining the behaviour (operational modes) or the Human Machine Interface (HMI) (display modes) or the control functions (control modes) of the equipment or its sensors

3.1.19
Mode Awareness:
The perception of the mariner regarding the currently active Modes of Control, Operation and Display of the INS including its subsystems, as supported by the presentations and indications at an INS display or workstation

3.1.20
Multifunction display
A single visual display unit that can present, either simultaneously or through a series of selectable pages, information from more than one operation of a system. (MSC 86(70), 3.5)

3.1.21
Navigation
Navigation is the process of planning and executing the safe and expeditious voyage of a ship, and of monitoring and recording its performance

3.1.22
Navigational aid
A ship-borne device that complies with its relevant International Standard [s], e.g. instrument or chart, intended to assist in the navigation of a ship

3.1.23
Part
An individual INS subsystem, equipment or functional module

3.1.24
Passage
The process of navigating a ship through a certain area within a certain period of time and under certain environmental and legal circumstances

3.1.25
Primary navigation data/information
Data of own ship's position, speed, heading, time and if available depth, provided by selected sensors, to be used in the system for processing the navigational information

3.1.26
Receiver Autonomous Integrity Monitoring (RAIM)
Function of a position receiver, using a reference system for position integrity calculations which is independent from the system providing the primary position data

3.1.27
Reliability
The probability of performing a specified function without failure under given conditions for a specified period of time

3.1.28
Route
Representation of a voyage or passage geographically defined by a point of departure, a point of arrival and usually by intermediate waypoints. It may include time of departure and/or ship's speed as well as parameters and limits for safe navigation such as off-track limit, turn radius, time references etc. and as defined in IMO Resolution A.893(21)

3.1.29
Sensor
A navigational aid, with or without its own display and control as appropriate, automatically providing information to the INS. (MSC 86(70), 3.6)

3.1.30
Situation Awareness:
The perception of the mariner regarding the prevailing nautical situation and the currently active or available system resources, as supported by the presentations and indications at an INS display or workstation. Situation Awareness includes Mode Awareness

3.1.31
Supplementary information
The information available for display in addition to essential information

3.1.32
System data (SD)
Data that is used by the system for the processing and display of essential information. System data of the same type is from the same source. System data, at least for primary navigation information, has been checked for integrity

3.1.33
System integrator
The organisation responsible for ensuring that the INS complies with the requirements of this standard

3.1.34
Track
Geographical representation of the movement actually performed by the ship, or, in case of a track control system, the path (over ground) to be (automatically) followed

3.1.35
Validity
The conformity of information with formal and logical criteria, or the marking of data as being good or no good (valid or invalid) for the intended use.(see also IEC 61162-1 clause 5.3.4)

3.1.36
Voyage
The process of sailing a ship from one location to another

3.1.37
Warning
Visual indication accompanied by a short audible signal, giving information about a condition of which the operator needs to be aware

3.1.38
Waypoint
A geographically defined position used as reference for navigation along a leg, track or route

3.1.39
Workstation for INS or INS workstation
Workstation at which display or operator control functions are provided to meet the requirements of this Standard. An INS workstation need not be a physical part of the INS. It may just be the location where the necessary displays and controls are situated

3.2 Abbreviations

AIS	Automatic identification system
ARPA	Automatic radar plotting aid
ATA	Automatic tracking aid
CCRS	Consistent common reference system
DR	Dead reckoning
ECDIS	Electronic chart display and information system
EUT	Equipment under test
EPA	Electronic plotting aid
EPFS	Electronic position fixing system
GNSS	Global navigation satellite system
HCS	Heading control system
HMD	Heading measuring device
HMI	Human machine interface
IBS	Integrated bridge system
IMO	International Maritime Organisation
IEC	International Electrotechnical Commission
INS	Integrated navigation system

ISO	International Organisation for Standardization
ITU	International Telecommunication Union
LORAN	Long range navigation system
MFD	Multifunction display
OoW	Officer in charge of the navigational watch (Officer of the Watch)
RAIM	Receiver autonomous integrity monitoring
RP	Radar plotting as implemented in ARPA, ATA or EPA
SDME	Speed and distance measuring equipment
STW	Speed through water
TCS	Track control system
THD	Transmitting heading device
TMHD	Transmitting magnetic heading device
VDR	Voyage data recorder
VDU	Visual display unit

4 Common requirements for all categories of INS

4.1 General

In addition to meeting the relevant requirements of Resolution A.694(17) to which IEC 60945 *is associated, the INS* shall *comply with the requirements* of the IMO Performance Standards MSC 86(70) Annex 3, as clarified in this International Standard.

4.1.1 Compliance

Each part of the INS shall comply with the applicable requirements adopted by IMO, including the requirements of IMO resolution MSC 86(70), except where specific deviations are noted within this International Standard. *Parts executing multiple operations shall meet the requirements specified for each individual function they can control, monitor or perform*. (MSC 86(70), 4.1.2).

4.1.2 Purpose of an integrated navigation system (INS)

The purpose of an integrated navigation system (INS) is to provide 'added value' to the functions and information needed by the officer in charge of the navigational watch (00W) to plan, monitor or control the progress of the ship. (MSC 86(70) 1.1) For this purpose a functional description shall be provided (see 4.17.1).

4.1.3 Three INS categories

This International Standard defines three categories of INS (see 1.4 The requirements of clause 4 are applicable to all three categories of INS, except where otherwise stated. The requirements specific to INS (A), INS (B) and INS (C) are detailed in clauses 5, 6 and 7 respectively. The relevant category of the INS shall be declared.

4.1.4 Safety of navigation support

The INS supports safety of navigation by evaluating inputs from several independent and different sensors, combining them to provide information giving timely warnings of potential dangers and degradation of integrity of this information. Integrity monitoring is an intrinsic function of the INS (MSC 86(70), 1.3) (see 4.5.7) as required by its category INS (A), (B), or (C).

4.1.5 Consideration of human factors

The INS aims to ensure that, by taking human factors into consideration, the work load is kept within the capacities of the OoW and other mariners on the bridge *in order to enhance safe and expeditious navigation and to complement the mariner's capabilities, while at the same time to compensate for their limitations* (MSC 86(70), 1.4), as required by its category of INS (A), (B) or (C) (see 4.13).

4.2 Basic functions

4.2.1 Combination, processing and evaluation

The *INS* shall *combine, process and evaluate data from all sensors in use* (MSC 86(70), 4.1.5) for obtaining information of speed, heading, position, time and, if available, depth, as required for the integrity evaluation see 4.5.7 .

4.2.2 Mode and situation awareness

The INS shall *support mode and situation awareness* (MSC 86 (70), 1.2) and shall fulfil this requirement by functional integration, processing and display by providing: -

- Validated data, where possible**,** of all connected navigation sensors (see 4.7)
- The specified INS information and its status (see 4.4.4, 4.8)
- The modes of operation, display, and control presently active, or available (see 4.8.4, 4.9 and 4.10)
- The changes of this information and their appropriate alarms and indications, as required by its category.

4.3 Functional Integration

The INS shall *provide functional integration meeting the requirements* (MSC 86(70), 4.1.16) of this International Standard and particularly the following clauses of 4.3:

4.3.1 Multiple display or control and associated processor

Where a display or control is presented on a multifunction display unit then these shall *be redundantly available.* (MSC 86(70), 4.1.16.1), i.e. where a multifunction display or processing unit satisfies display, control or processing functions according to multiple SOLAS carriage requirements, then these functions shall be redundantly available. [The redundancy concept and implications for the availability of functions shall be explained in the operation manual].

Note: a) In case of a failure of the multifunction display or processing unit, the redundant functions must still simultaneously support all functions required by the relevant International Standards, except where specific deviations are noted within this International Standard (see 4.11.2)."

[Note: b) The redundancy concept shall be such, that a fault of one multifunctional display or processing unit does not result in the simultaneous information of more than one required navigational aid becoming unavailable.]

4.3.2 Sensor or part thereof

A sensor or part thereof is not part of the INS if it only supplies data and does not perform other functions of the INS as required by this standard.

4.3.3 Actuator, controller or part thereof

An actuator, controller or part thereof is not part of the INS if it only receives data or commands and does not perform other functions of the INS as required by this standard.

4.4 Interfacing and data exchange

4.4.1 Interfacing to the INS

Interfacing to, and from, the INS shall *comply with International Standards,* namely IEC 61162 series, *as appropriate* and applicable.(MSC 86(70), 7).

4.4.2 Interfacing stand alone equipment

Stand alone equipment for which performance standards adopted by IMO exist, when connected to the INS, shall *comply with IEC 61162 series as applicable, for data exchange and interfacing* (MSC 86(70), 4.1.12). Where existing installed equipment has no compatible IEC 61162 interface; an alternative interface may be used. Details about the available interfaces and thereby supported functions for data import and -export shall be included in the operation and installation manuals.]

4.4.3 Integrity of data exchange

The integrity of the data exchange within the INS shall *be ensured.* (MSC 86(70), 4.1.14). (see 4.11.2.4).

4.4.4 Accuracy and performance

As a minimum, the accuracy and other properties *of information* shall *meet the requirements of the resolutions* [2] *adopted by* IMO.(MSC 86(70), 4.2.4) for the individual navigational aids connected to or forming part of the system.

Note: Other properties may include update rate, range, resolution, validity, etc., as specified in the relevant standard.

4.4.5 Accuracy maintenance

Additionally the INS shall *not degrade the accuracy of the data provided by the sensors* (MSC 86(70), 4.2.4). In order to ensure that the required accuracy is maintained the INS shall not degrade the data provided by the sensors to less than the minimum resolution values as shown in table 1.

When data is derived from data types listed in table 1, at least the minimum resolution listed therein shall be used when calculating the derived data. Additionally, primary navigation information derived by the INS shall meet the accuracy requirements of the relevant individual International Standards. Data of types listed in table 1 shall be distributed using at least the resolution as listed therein.

Table 1 Minimum Resolution of INS information

Own Ship Data	Required Minimum Resolution
Position	1/1000 of a minute
Speed	1/10 kt
Depth	0.1 m up to 9.9 m of depth; 1 m above 9.9 m of depth
Heading	0.1 deg
Course	0.1 deg
Date/Time	1 s

4.5 Consistent common reference system (CCRS)

The INS shall *ensure that the different types of information are distributed to the relevant parts of the system, applying a 'consistent common reference system' for all types of* essential *information* (MSC 86(70), 4.1.6) as follows (see also Annex C):

4.5.1 System data (SD)

Data that is used for processing, display or output of essential information shall be distributed as system data (SD). As a minimum, system data includes position, speed, heading, time and, where available, depth. All system data of the same type shall be from the same source.

4.5.2 Distribution/display of system and other navigational data

Where it is possible to distribute or display both system and other data of the same type, means shall be provided to distinguish between them.

4.5.3 System data distribution

Dynamic system data shall be distributed throughout the INS at intervals of not less than 1 s or as required for an individual part and shall be consistent with the distributed system time to within 0.1s.

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2 IMO Resolutions A.529(13) and A.815(19)

A specific type of static system data shall be available from only one source, or shall automatically be updated in the relevant parts of the system.

4.5.4 Reference location

At any given time, the system shall use a single reference location (see note below), on the ship, for all spatially -related information. Information may be referenced to an alternative location in which case this alternative reference location shall be clearly indicated or distinctively obvious. Operational implications caused by using different reference locations or deviations from established practice (see note below) shall be included in the operations manual.

Note 1: This may be a deviation from the present radar standard. (See 4) Radars have traditionally referenced the display to the antenna turning unit, other displays are normally referenced to a geospatial position. This may lead to different values for range, bearing and derived information for; visual observations, radar(s), AIS and chart.

Note 2: The recommended reference location is the conning position. An alternative location is the bow of the ship (e.g. pivot point or radar antenna).

4.5.5 Distributed position reference

Position data shall be distributed within the system and to external equipment only in the WGS 84 datum. Where external position information is available in another datum, this may be imported and used only for planning and datum conversion purposes, if appropriately marked.

4.5.6 Sources and distribution of speed references

Both STW and SOG speed data, as available, shall be distributed within the system and to external equipment as required for the relevant functions and selected by the mariner.

The operation manual shall include appropriate details about the different sources and application of speed information, STW, SOG from SDME, SOG from GPS, including limitations and, as part of the failure analysis as per 4.15, consequences in case of loss of such information.

4.5.7 Integrity monitoring

The integrity of essential information shall *be* monitored and *verified automatically before* such *essential information is displayed or used. Information with doubtful integrity* shall *be clearly marked by the INS and* shall *not be used for automatic control systems (MSC 86(70), 4.1.11*),

The integrity of data from different sensors shall be evaluated prior to distribution to other parts of the INS or to external devices. (MSC 86(70), (4.1.5) as follows:

4.5.8 Verification of sensor data integrity

The integrity of information, selected for use by the INS shall *be verified by comparison of the data derived independently from two or more sources, if available* (MSC 86(70), (4.1.10). As a minimum, the following integrity monitoring and verification measures shall be performed before being used as system data (See Annex D for a summary of integrity measures).

4.5.8.1 Integrity of position data

The integrity of position data shall be checked automatically against a RAIM function of the position sensor, or with a secondary position sensor, or against a position derived from speed, heading and time independent of the position sensor data.

4.5.8.2 Integrity of speed data

The integrity of speed data shall be checked automatically against a secondary source of speed such as a second speed sensing method of the speed sensor, or against the speed information provided by the position sensor or derived from position information.

4.5.8.3 Integrity of heading data

The integrity of heading data shall automatically be checked against secondary heading sensor data, where available.

4.5.8.4 Integrity of time data

The integrity of time data shall be checked automatically against a secondary source of time data, which may be an internal time counter with a drift of no more than 2 min within 30 days of non-updated operation.

4.5.8.5 External functions for integrity monitoring

Required functions for integrity monitoring, except for the required alarms and indications, may be part of an external sensor or subsystem. In such case the operating and installation manuals shall include the details of such sensors or subsystems required and their required settings.

4.5.8.6 Input of set and drift

If integrity checks use STW data or data derived from STW, the system shall provide for input of set and drift, in order to avoid false alarms. Set and drift may include other effects in addition to water current. The set and drift being used for integrity checks shall be derived independently from the sensor being checked.

4.5.8.7 Alternative methods of integrity checks

Alternative automatic methods of integrity monitoring which provide at least the equivalent performance to those specified in 4.5.8 may be used (see Annex D).

4.5.9 Marking of data

4.5.9.1 Marking of invalid data

The status of the data verified for integrity as per 4.5.8 shall be marked “invalid” , when the deviation between the data from the primary sensor and the secondary sensor(s) is greater than two times the expected precision of the secondary sensor or 10 times the expected precision of the primary sensor, whichever is the smaller.

4.5.9.2 Marking of doubtful data

The status of the data shall be marked "doubtful", when the deviation becomes greater than 50% and smaller than 100% of the above value.

4.5.9.3 Marking of derived data

Where information is not directly received from a sensor i.e. is derived such as for DR, this also shall be verified by comparison with data from at least one sensor of that type. However, if no independent sensor is available, the sensor data used for comparison may be independent of the derived data. The derived data shall be marked invalid when it deviates from the sensor data by more than 3 times the expected accuracy of that sensor. Data, which deviates by more than 50% of the limits, shall be marked as “doubtful”.

4.5.9.4 Adaptable limits

The limits specified in 4.5.9.1 - 4.5.9.3 may be adaptable depending on the navigation conditions, such as speed and turning rate, or depending on the required steering capability in case of an INS (C), and shall be documented in the operating manual.

4.5.9.5 Short-term and long-term checks

Integrity checks performed by using data from sensors that may develop drift errors, such as speed or heading, shall include both; a short-term check for the immediate acquisition of new data, as well as a long-term check for the monitoring of possible progressive degradation of integrity.

4.5.9.5.1 Marking status from long-term check

When the long-term check fails, the status of the system data shall be marked at least as “doubtful”.

4.5.9.5.2 Marking status from short-term check

When the short-term check fails, the status of the system data shall be marked as “invalid”.

4.5.10 Generation of markings and alarms

4.5.10.1 Delayed alarm

In order not to generate unnecessary alarms and fall-back situations for short term sensor errors, the generation of markings of the invalid or doubtful data and the resultant alarms may be delayed for a period of up to 30 sec but not for a period infringing set limits for the proximity to known hazards or other limits for safe navigation (see also 4.12.4). In such cases at least a warning shall be generated immediately.

4.5.10.2 Invalid sensor data

Information from sensor data, which have been designated invalid by the sensor itself, shall be displayed with an indication of “active alarm” according to 4.12.3, even if the integrity check does not otherwise detect a lack of integrity. Such information shall not be used for any automatic heading, course, track, or speed control functions.

4.5.10.3 Invalid essential information

If essential information becomes invalid an alarm shall be given. For other missing or invalid data at least a warning shall be provided. If primary navigation data currently processed for essential information, becomes doubtful an alarm shall be given.

4.5.10.4 Impossible integrity verification

At least a warning indication shall be provided if integrity verification is not possible, due to lack of secondary data. In case of INS (C) an alarm shall be given if in an active control mode.

4.5.10.5 Other information with doubtful integrity

Any other information with doubtful integrity shall, be marked with at least a warning indication.

4.5.10.6 Successfully checked essential information

All essential information successfully checked for integrity shall be marked as valid for further distribution to other parts of the INS and for data output interfaces, if any. (See 4.10).

4.6 Latency

Data latency shall *be consistent with the data requirements of the individual parts* (MSC 86(70), 4.1.13) for processing, display or output of information, as follows:

4.6.1 Latency of sensor information

The latency of information between sensor output and display shall not exceed 2 seconds.

4.6.2 Multiple sensor process information

Where more than one sensor input is used to process or display combined information, such as a dynamically displayed object, latencies of data shall be compensated, e.g. by prediction to a common time, and dynamic properties of the object shall be correlated in such a way, that the requirements of 4.4.5 and 4.6.1 are met for the resulting information.

4.6.3 Data filtering

If data is filtered, e.g. for achieving dynamically consistent display of information, any resulting latency exceeding the above requirements shall be compensated by appropriate predictions. The resulting accuracy of the information must still meet the requirements of 4.4.5.

4.7 Validity

Validity of the data shall be provided for each part to be integrated. (MSC 89(70),4.1.16.2) as follows:

4.7.1 Validity checks

The validity of the data received from sensors and used or distributed by the INS shall be checked as a minimum for plausible magnitudes of values. Data that fail the checks or are flagged invalid by the sensor or as a result of integrity monitoring (see 4.5.8) shall be indicated as invalid in all output interfaces.

4.7.2 Invalid data

Invalid data, including that which is missing or corrupted, shall not be further processed or used by the INS. Invalid data shall not affect any other function or functions not dependent on these data. Display fields allocated to any data found missing or corrupt, shall be marked invalid in accordance with 4.12.3.

4.7.3 Indication of invalid information

When data required for essential information or for a required control function is becoming invalid, an alarm shall be given. When other data is becoming invalid, this shall be indicated at least as a warning. (see 4.12.3).

4.8 Displayed information

4.8.1 Display of available information

The INS shall *be able to display the information available in accordance with* paragraphs *4.1.7, 4.1.8 and 4.1.9* of Res. MSC 86(70), *as applicable*. (MSC 89(70), 4.2.1) and as required by this International Standard, (see also 4.2.2 and 4.13), The display required for presenting this information may be a dedicated display or a display of any available navigational aid. The display of such navigational aid then forms part of the INS.

4.8.2 Continuously displayed information3

Continuously displayed information shall be optimised for good readability and operator perception.

4.8.3 Display of essential information

The following essential information shall be available for continuous display:

- Ownship geographic position, which shall be displayed as WGS84 (N/S - E/W),
- Speed through the water or over the ground,
- [True] heading,
- Time (UTC or local),
- Depth [of water under keel (where available),]
- System status,
- Display mode (where not distinctively obvious),
- Mode of operation (where not distinctively obvious).

All of this essential information shall be displayed upon a single operator command. *Supplementary information* related to the essential information shall then *be readily accessible* (MSC 86(70), 5.2.3), i.e. be selectable individually or in groups upon single operator command.

4.8.4 Display of event related essential information

The following essential information shall automatically be displayed, upon occurrence of the relevant event, in a format different and easily distinguishable from other information:

- Alarms and warning indications;
- Changes of system status;
- Automatic changes of display or operational modes;
- Automatic change of the available system configuration.

4.8.5 Content of information for display (MSC 86(70), 4.2.3)

The essential *information* shall *be displayed together with the indication of it's: -*

- Source; (sensor data, e.g. GYR 1, GYR 2, GPS 1, GPS 2, LORAN, EM log, Doppler log etc.);,
- "result of calculation" or "manual input" **(**where otherwise the information may be ambiguous);,
- unit of measurement (where not otherwise obvious),
- status(see also sub-section Integrity monitoring, 4.5.8), and including
- the operational mode (if a sensor can operate in different modes).

4.8.6 Display of additional information

Additional navigational information may be displayed, provided it does not mask, obscure or degrade essential information required for display by this International Standard.

4.8.7 Operator controls and associated indicators

All of the controls and related indicators for the following functions:

- Display of essential information;

- Display and acknowledgement/cancellation of alarms;
- Sensor selection, sensor monitoring and display of sensor information;
- Selection of operation, display and control modes;

shall be available, at least at one INS workstation, at any given time and as relevant to the INS category.

4.8.8 Display of sensor output data

The INS shall *be capable of displaying* information from the *output data available from the sensors* (MSC 86(70),4.2.2).as well as output information generated by the INS.

4.9 Modes of operation or control in use

If the mode in use is not the normal mode to fully perform the functions required for the relevant INS category, this shall be clearly indicated,. Examples of modes other than the normal mode of operation are:

- ‘Fall-back’ modes, in which the INS cannot fully perform all functions of its category. For instance, typical fallback modes for an INS(C) are those which still support the required functions of INS(B) or (A).
- ‘Service modes’ including ‘test’ ‘simulation‘ or other modes, in which the INS cannot be used for navigation.

4.10 Configuration display

It shall *be possible to display the complete system configuration, the available configuration and the configuration in use* (MSC 86(70), 4.1.17), as a graphic presentation or as a list. The information shall be detailed to the level of INS subsystems, sensors, and other connected equipment providing information to the INS.

4.11 Malfunctions

4.11.1 Failures

4.11.1.1 Failure effects

A failure of one part shall *not affect the functionality of other parts except for those functions directly dependent upon the information from the defective part*. (MSC 86(70), 4.1.4).

4.11.1.2 Malfunction of additional facilities

When equipment or *functions of equipment connected to the INS provide facilities in addition to this International Standard, the operation and as far as is reasonably practicable, the malfunction of such additional facilities* shall *not degrade the performance of the INS below the requirements of* this International Standard (MSC 86(70), 4.1.3).

4.11.1.3 Failure of one part

A failure of one part shall immediately be indicated by an alarm, if this failure requires immediate operator attention as defined and documented by the manufacturer. Other failures shall at least be indicated as warnings.

4.11.1.4 Automatic response to malfunctions

The system's automatic response to malfunctions shall *result in the safest of any other configuration* or mode of operation as documented by the manufacturer, *accompanied by clear indications and alarms*. (MSC 86(70), 4.3.1). (See also 4.11.2 and 4.15)

4.11.2 Fall-back arrangements

4.11.2.1 Continued availability of essential data

The INS shall*, after a failure, support the availability of essential information through the use of appropriate fallback arrangements* (MSC 86(70), 8.1) (See also 4.8.3 and 4.11.2.4).

4.11.2.2 Independent functionality

A failure of data exchange shall *not affect independent functionality* of parts (MSC 86(70), 4.1.15); [i.e. the data exchange shall be designed in such a way, that despite of a failure of one part used for INS data exchange (which may be a navigational aid forming part of the INS), the other navigational aids or multifunctional display or processing units forming part of the INS shall continue to be operational, at least with alternative sources of information.]

4.11.2.3 Restored operation

Normal operation, after use of a fallback arrangement, shall *only be restored upon confirmation by the operator* (MSC 86(70), 8.2).

4.11.2.4 Separate or redundant operation

In case of failure in one part, it shall *be possible to operate each other individual item of equipment or part of the system separately* (SOLAS V/19.6.) Alternatively, parts and information may be provided redundantly to ensure continued operation after a failure. (see 4.3.1)

4.11.2.5 Failure or change of sensor

In case of a sensor failure, the system shall automatically provide a confirmable indication of (an) alternative source(s), as available. The failure or change of a sensor shall not result in sudden changes of control commands or loss of manoeuvring control. This may be accomplished by appropriate filtering techniques using the information from several sources, e.g. by dead reckoning. (see 4.6.3)

4.12 Alarms and indications

4.12.1 Alarm Management System

An alarm management system shall *be provided* (MSC 86(70), 4.3.3) by which the INS shall present alarms or appropriate indications when any limits for alarms are exceeded or conditions for required indications are met, or when operator intervention is required to maintain or re-establish the selected modes of the system.

The INS alarm management system, as a minimum, shall *comply with the requirements* of IMO Resolution A.830(19) and (MSC 86(70) 4.3.4.

4.12.2 Alarms/Indications and related messages

The INS shall provide alarms and indications including related messages with the following levels:

1) Alarms
2) Warnings not related to alarms
3) Other indications.

If more than one alarm or warning is simultaneously active, a chronological listing shall be accessible by the operator.

4.12.3 Presentation of alarms, warnings and indications

Alarms, warnings and indications shall be presented as shown in table 2

Table 2 Alarms, warnings and indications

Condition	Visual	Audible
Active alarm, not acknowledged	Red, blinking (see note 1)	Yes (see note 1)
Active alarm, acknowledged	Red, steady (see note 2)	No
Invalid information, dangerous condition	Red, steady (see note 2)	No
Active warning, not acknowledged	Yellow, (steady or blinking) (see notes 2 and 3)	Yes (see note 4)
Acknowledged warning, doubtful information	Yellow, (steady) (see note 5)	No
~~doubtful information~~	~~Green steady or no indication~~	~~No~~
Indication of normal status / condition	Green steady or no indication	No

Note 1: A visual red blinking indication of a relevant information or alarm display field shall be accompanied by an audible alarm signal and an alarm message. If not acknowledged, visual and audible indications, including the marking of relevant information display field(s), and the alarm message shall remain until the ~~alarm~~ condition is normal. The audible alarm signal may be suppressed or replaced by an audible warning signal in a mode of navigation or display for harbour manoeuvring, but not for alarms related to loss of valid ~~position,~~ speed, or heading information or loss of control.

[The audible alarm signal shall be repeated and the alarm message displayed for acknowledged active alarms after not more than 10 minutes, if the alarm condition still exists.]

Note 2: The visual indication(s) including the marking of relevant information display fields, shall remain until the condition is normal. The related alarm message shall be available on request.

Note 3: The visual indication(s), including the marking of relevant information display fields, shall be accompanied by a warning message which, if it covers other essential information, shall remain for only a short period (2 - 5 sec) during which time the indication may be blinking, until acknowledged, or until condition is normal.

Note 4: At least in case of a warning, the indication shall be accompanied by a short audible signal (0,1 - 0,5 seconds). Differently modulated audible signals may be used for different types of warnings, but in no case shall they exceed the maximum duration of 0,5 sec. The audible warning signal may be suppressed in a mode of navigation or display for harbour manoeuvring.

Note 5: The visual indication shall remain until the condition is normal, the related warning message shall be available on request.

4.12.4 Number of Alarms

The number of alarms shall *be kept as low as possible by providing indications for information of lower importance.* (MSC 86(70), 4.3.5). A single event shall not cause different alarms on the same or different INS Workstations. The acknowledgement or cancellation of an alarm at one INS Workstation shall cause the alarm to be acknowledged at all INS workstations as well as at the part causing the alarm, as relevant, see 4.12.9.

4.12.5 Alarm display

4.12.5.1 Information relating to alarms

Information relating to alarms initiated by the INS or received from connected sensors or control systems shall *be displayed so that the alarm reason and the resulting functional restrictions can be easily understood. Indications shall be self-explanatory*; (MSC 86(70), 4.3.6)

4.12.5.2 Alarm display field or window

An alarm display field or window shall not obscure other essential information, unless the alarm display can be removed by a single operator action. When the alarm display is removed, there shall be an indication if an alarm condition continues to exist.

4.12.6 Alarm cancellation

Cancellation of an alarm shall only be possible at an INS workstation, ~~at the location~~ from where the cause for the alarm and its implications can be monitored, otherwise cancellation shall only be possible at the device causing the alarm.

4.12.7 Back-up officer alarm

An alarm message according to IEC 61162 shall be released or a related insulated contact be opened when the INS has initiated or received an alarm for calling a back-up officer. The back-up officer alarm shall be initiated, when an alarm has not been acknowledged within 30 sec. Acknowledgement of a back-up officer alarm shall only be possible from a location on the ship's bridge. The installation manual shall include appropriate details.

4.12.8 Remote audio alarm suppression

The INS shall have the capability to acknowledge (suppress the audible) alarm signals for sensors and control systems that are part of the INS and provide alarms to the INS.

4.12.9 Remote alarm cancellation

The INS shall have the capability to remotely cancel alarms of sensors or control systems that are part of the INS and of which the information related to the alarm is displayed at the relevant INS workstation.

4.12.10 Output to a central alarm system

If the INS is connected to a central alarm system or to a higher order integrated system such as an IBS, it shall provide alarm outputs complying to IEC 61162 or in form of insulated contacts, as follows:

4.12.10.1 General failure alarm

An alarm message shall be released or a related contact be closed when the equipment is switched on but basic functions (hardware or software) or the power supply are failing.

4.12.10.2 Hazard alarm

An alarm message shall be released or a related contact be opened when the INS has initiated or received from an integrated sensor an alarm related to a radar, AIS or chart object, or shallow depth.

4.12.10.3 Control alarm

An alarm message shall be released or a related contact be opened when the INS has initiated or received an alarm related to an automatic steering or speed control function.

4.12.10.4 Sensor alarm

An alarm message shall be released or a related contact be opened when the INS has initiated an alarm for a failure of system position, - speed, - heading, - time or depth.

4.12.11 Alarm input

The INS shall have the capability to receive all alarms available from connected sensors and control systems. If the INS is connected to a central alarm system or to a higher order integrated system such as an IBS with central alarm functions, it shall provide alarm inputs complying to IEC 61162 or in form of insulated circuits to sense open or closed contacts, as follows:

4.12.11.1 Remote audio alarm suppression

The INS shall have the capability to receive / sense acknowledge signals or contacts and shall in such case suppress the audible alarm signal for relevant alarms that have been outputted to remote systems.

4.12.11.2 [Remote alarm cancellation

The INS may have the capability to receive / sense cancellation signals or contacts and shall in such case cancel the alarm signal for relevant alarms that have been outputted to remote systems. In such case the installation manual shall include instructions, that such cancellation functions shall only be activated if the INS displays containing the relevant information can be monitored from the relevant remote location.]

4.12.11.3 Central alarm system failure

The INS shall have the capability to receive / sense a failure alarm signal or contact of a connected central alarm system or higher order integrated system such as an IBS with central alarm functions, and in case of a signalled failure shall initiate an appropriate alarm.

4.13 Human Machine Interface (HMI)

Integrated display and control functions shall *adopt a consistent HMI philosophy and implementation* (MSC 86(70), 5.1.1), *paying particular attention to symbols, control*s *and layout* (MSC 86(70) 5.2.1) as follows:

4.13.1 Controls and associated displays

The following functions and designations of their related controls and displays shall be consistent for comparable operator interactions at each specific display and its controls:

- Activating an input field
- Entering, editing, skipping, deleting or acknowledging an operator input
- The structure of a displayed operational menu
- Call-up of a menu item or entry or selection field
- Leaving a menu after or without performing an input
- Performing interactive graphical operations
- Selecting, storing, retrieving, calling-up or listing data from/to memory or to a data storage device
- Selection of or changing the mode of operation.

4.13.2 Abbreviations or symbols

If abbreviations or symbols are used, they shall follow the requirements specified in:

- IEC 60936 / 60872 (Radar / Radar plotting) or;
- IEC 61174 (ECDIS),
- as relevant, and if not specified therein, then;
- IEC 61209 (IBS) or
- IEC 61162 (Interfaces)

4.13.3 Position co-ordinates

All position co-ordinates shall be displayed in the WGS 84 datum and Lat/Lon convention. Other co-ordinate systems may be used, [except for the regular display field of own ship's

position], for presenting specific information when accompanied by a clear indication in every case.

4.13.4 Units of measurement and reference

The same unit of measurement and reference (e.g. datum) shall be presented / used by the system for the same type of information. Other units of measurement may be displayed upon operator selection when accompanied by a clear indication.

4.13.5 Information display

The HMI shall *be so designed that the provided information is clearly understood using a consistent presentation style.* (MSC 86(70), 5.1.2). The following elements of the HMI shall be consistently applied:

4.13.5.1 Similar display location

Essential information shall be presented at a similar location of the display, in display modes of similar appearance, regardless of the mode of operation.

4.13.5.2 Grouping of related information

Logically related information, such as pre-set and actual values shall be displayed in groups

4.13.5.3 Designations of windows

Different displays or “windows” with similar appearance shall be differently designated

4.13.5.4 Distinguishable information

The presentation of variable information shall be clearly distinguishable from that of static information

4.13.5.5 Character size

The variable information elements shall be displayed with characters height in mm of not less than 3,5 times the reading distance in metres, and the nominal character width, shall be 0,7 times the character height.

4.13.5.6 Missing information

Display fields for information that is not received but expected, shall be distinctively marked.

4.13.5.7 Context menu

A ‘window’ or ‘context menu’ may be opened manually to temporarily display certain information or menu items. Such ’window’ may cover essential information only during relevant operator interaction by, for example, ‘spring loaded key’; time out or equivalent function. Such function may be additionally applied to a navigational aid forming part of the INS, in order to avoid an overload of information at its normal display.

Note: This function may deviate from individual equipment standards (see clause 4).

4.13.6 Colour tables

Appropriate colour tables for INS displays shall be selectable for adaptation to the ambient light condition.

4.13.7 Manual inputs

The HMI shall *be so designed that the requested manual inputs can be easily executed.* (MSC 86(70), 5.1.3) as follows:

4.13.7.1 Pointer device

In the case of a graphical user interface, which allows, requests, or requires prompts for inputs from an operator, a pointer device shall be part of the HMI and shall allow access and activation of any input field on the current display within 2 seconds.

4.13.7.2 Active input field

When the system requests or prompts for a specific operator input required for continued operation, the relevant input field shall be available, automatically, for immediate operator entries and marked as active.

4.13.7.3 Keyboard

If the INS requires numerical or alphanumerical inputs, an ASCII-keyboard (or equivalent temporary keyboard window of the display screen) with the QWERTY 3 arrangement of the keys shall be used. If a numerical keypad is connected, its keys shall be arranged in accordance with ISO 3791.

4.13.7.4 Input errors

For manual inputs that may cause unintended results, and which, because of input errors, may lead to sudden manoeuvres or loss of data, *the INS shall request confirmation before acceptance*, *thus providing* the operator the time for *a plausibility check*. (MSC 86(70), 5.1.4).

4.13.7.5 Checking of entries

As far as practicable, all entries shall be checked by the INS for plausibility before they are further processed. An indication shall be given when an implausible entry has been made. An appropriate message, including a proposed corrective action, shall be displayed when necessary.. The system shall not automatically close an entry field without operator action.

4.13.8 Operation of basic functions

The INS shall *be designed and implemented*, according to the following requirements, *so that the OoW can easily operate basic functions from INS workstations* (MSC 86(70) 5.2.2).

Note: An INS workstation need not be a physical part of the INS, it may just be the location, where the displays and controls, that are required to comply with this International Standard, are situated.

4.13.9 INS workstation for all operator functions

All operator functions and related displays, controls and indicators required by this standard for any INS category shall be available from at least one INS workstation, except for extended route planning functions.

4.13.10 Lay-out of INS workstations

An INS workstation may include displays such as; radar, ECDIS or conning and their associated controls. Other types of displays are permitted in addition to the graphical displays. The displays of one workstation shall not be separated by more than the reading distance allowed in compliance with (4.13.5.5). Required operator controls of one workstation

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3 The keyboard arrangement shall be in accordance with ISO-IEC 9995 Part 2 Annex A Figure A1 with the QWERTY arrangement to the exclusion of other arrangements allowed for in that International Standard.

shall not be separated by more than 160 cm. The installation instructions shall include the necessary details.

4.14 Power supply

4.14.1 Power supply requirements

Power supply requirements applying to parts of the INS as a result of other IMO requirements, shall *remain applicable*. (MSC 86(70), 6.4).

4.14.2 Power sources

The INS shall *be supplied*:

- *From both the main and emergency source of electrical power with automated changeover through a local distribution board with provision to preclude inadvertent shut down*; and
- *From a transitional source of electrical power for a duration of not less than 45 s.* (MSC 86(70), 6.5)

The manufacturer shall declare that this arrangement is part of the INS under test or shall describe the necessary means required in the installation manual.

4.14.3 Orderly shut down

If subjected to an orderly shutdown, the INS shall, upon turn-on come to an initial default state.

4.14.4 Power interruption

4.14.4.1 Recovery time

After a power interruption full functionality of the INS shall *be available after recovery of all subsystems. The INS* shall *not increase the recovery time* beyond that required by the standard of the *individual subsystem* or its *functions after power restoration.* (MSC 86(70) 6.6).

4.14.4.2 Functions after recovery

If subjected to a power interruption the INS shall*, upon restoration of power maintain the configuration* and mode *in use and continue automated operation, as far as practicable* or as specified in the individual equipment standard*. Safety related automatic functions*, e.g. automated steering control, shall *only be restored upon confirmation by the operator*. (MSC 86(70), 6.7).

4.15 Failure analysis

4.15.1 Failure analysis - system configuration

A failure analysis[5]*,* at functional level, shall *be performed and documented for the configuration of the INS* proposed to be installed *which includes all parts connected to or integrated into the system, including devices for manual override of automatic functions and their proposed locations on the bridge*. (MSC 86(70) 6.2).

4.15.2 Failure analysis block diagram

The Failure analysis shall refer to a block diagram in a narrative format to enable the failure effects to be understood. The block diagram shall illustrate the interrelationship and functional interdependence of the system elements.

4.15.3 Failure analysis elements

The failure analysis shall comprise the following items:

- The individual equipment name or number and function
- Failure modes and reasons of failure, for each individual equipment
- The local effect and end effect (system function)
- Failure detection and alarm condition (locally and main system)
- System related corrective measures with indication of system status
- Fall-back mode of operations (as applicable).

4.15.4 Failure analysis classification

The failure analysis shall also include classification of the severity by indicating minor, major or hazardous end effect and consequential limitations of the system performance in the case of continued system operation.

Note An example of a Failure analysis worksheet matrix that covers the items specified above (and guidance for the use of Failure analysis) can be found in IEC 60812.]

See also IEC Publication 61508

4.16 Quality assurance

The integrator of the complete system and/or the *manufacturers* of the parts of the system shall *have a Quality Control System audited by a competent authority to ensure continuous compliance* with the requirements of this international standard. (SOLAS Ch V, 18.5)

4.17 Manuals

In addition to the IEC 60945 requirements, adequate information shall be provided as follows:

4.17.1 Operating manuals

Operating manuals shall include:

- An overall functional description of the INS, also addressing the ‘added value’ (see 4.1.2), as compared to relevant stand-alone navigational aids;
- in case of multifunctional workstations, displays or processors: The redundancy concept and implications for the availability of functions; (see 4.3.1);
- details about the available interfaces and thereby supported functions for data import and -export (see 4.4.2);
- a failure analysis (see 4.15);
- the limits for alarms and warning indications (see 4.12.1);
- the implications of using different reference locations (see 4.5.4);
- details about the different sources and application of speed information, STW, SOG from SDME, SOG from GPS (see 4.5.6);
- details of sensors or subsystems required for external integrity monitoring and their required settings (see 4.5.8.5);
- limits for marking valid, doubtful and invalid data and adaptable limits (see 4.5.9.4);
- INS (B): Information for configurations that provide superimposition of radar signal and chart information including suitable compasses and their limitations (see 6.2.3);
- INS (B): Conditions under which target data from sensors are merged or de-merged and the limitations of the process (see 6.5.3.11);

- INS (C): Details of the installed system configuration, and possible consequences, if different sensors for heading are used by for the INS and for the control system (see note to 7.6.1 and 7.3.3);
- INS (C): Functional description and the necessary details for external override or bypassing devices (see 7.8).

4.17.2 Installation manuals

The installation manuals shall include adequate information to *allow the INS to be installed so that it can meet the requirements of the relevant international standards*, namely IEC 60092-101 and IEC 60533 (MSC 86(70), 6.3) and additionally the installation manuals shall include the following:

- The approved configuration/s and all necessary information pertaining to this (see 1.3);
- the environmental requirements and limitations for the operation of the equipment (see 4);
- details about the available interfaces and thereby supported connections for data import and -export (see 4.4.2);
- details about connecting devices for cancellation of back-up officer alarms (see 4.12.7);
- instructions for the installation of facilities for remote alarm cancellation (as relevant see 4.12.9);
- the physical details of the permitted lay-out of the displays of the INS workstations in accordance with requirements of 4.13.10;
- the details of the power supply arrangements required in accordance with 4.14.2;
- the interconnection diagrams and interfacing details for external parts of the INS and for devices to be connected;
- INS (B): Details about approved compasses for configurations that include superimposition of radar signal and chart information (see 6.2.3);
- INS (C): Details about safe connections to approved heading and/or track control systems and/or to rudder and/or propulsion control devices (see 7c));
- INS (C): If voyage recording is an external function, necessary details for the required recording equipment and connections to it (see 7.2.2);
- INS (C): Installation of separate indicators for rudder angle, propulsion data - e.g. power, propeller pitch, as relevant (see 7.4.1);
- INS (C) with speed control: details about safe connections to supported propulsion control systems (see 7.7.1);
- INS (C) with speed control: requirements for installation of a speed control mode selector switch or manual override facility (see 7.7.3);
- INS (C): Functional description and necessary details for correct interfacing to external override or bypassing devices (see 7.8).

5 Requirements applicable to INS(A)

The INS(A) shall*, as a minimum, provide the information of position, speed, heading and time, each clearly marked with an indication of integrity* (MSC 86(70), 4.1.7), as specified in sections 1 – 4 above.

6 Requirements applicable to INS(B

6.1 General

INS(B) shall, in addition to the functional requirements of INS(A), *be able to automatically, continually and geographically indicate the nautical situation including the ships position, speed and heading in relation to the ship's route, as well as to known and detected hazards*

(MSC 86(70), 4.1.8). Where the depth is available from an echo-sounding device, depth shall be displayed.

6.1.1 Workstation for INS (B)

All required parts for display and operator control functions shall be provided for installation into a workstation at the conning position. In addition to the requirements of this standard the content and capabilities of the display shall at least meet either:

a) A radar with chart facilities meeting the requirements of IEC 60936-3; or

b) The combination or integration of a radar plotting device meeting the requirements of IEC 60872-1 or 2 with an ECDIS meeting the requirements of IEC 61174.

If AIS is installed, the INS (B) shall additionally have the minimum capability to superimpose AIS targets on the radar video together with RP targets and shall also meet the requirements of IMO S/N Circ. 217 (see also 6.5).

Note: ECDIS or RP are not necessarily parts of an INS.

Note: If an ECDIS or radar with chart facilities is not part of the INS (B) for providing the display of known hazards, it must be ensured by system design, that the known hazards can be provided from official charts.

Note: If an RP, is not part of the INS (B) for providing the display of detected hazards, it must be ensured by system design, that the detected hazards are to be provided from a RP that meets the relevant International Standard.

6.1.2 Display size

The size of the display(s) shall meet the relevant requirement for readability as per IEC 60945 and ISO 8468. If a display of the INS is designated to replace the display(s) of a navigational aid(s) required by SOLAS, such as radar, RP, and/or charts (by means of ECDIS), then the display(s) shall meet the relevant technical standard(s)

6.2 Accuracy and consistency of graphical information

6.2.1 Object differences at the same display

The INS display(s) shall not degrade the accuracy of the presentation of objects from different sources. The difference between radar detected, chart based and AIS reported objects as presented on the same display shall not be greater than 1/1000 of a minute for static object positions, or 0,1 deg for static orientations, not including sensor errors.

6.2.2 Objects differences between different displays

If a geographical object is presented at different physical displays, the cursor readout of ranges or bearings to the same object shall not differ by more than 0,01nm and 0,5deg (not including sensor errors) at a range setting of 1,5nm or equivalent scale. The presented difference in range may be proportionally larger at greater range settings or smaller scales. However, the relations between objects from different sources shall comply with 6.2.1

6.2.3 Matching of radar and chart images

For systems that provide composite displays for radar images superimposed with chart information, the accuracy and latency of heading information shall be suitable. The installation instructions shall include appropriate details about approved compasses for such configurations, and the operation manual shall include appropriate information about such configurations including their limitations.

The INS may include automatic image matching functions, and in such case shall monitor the differences between the source images equivalent to integrity monitoring of position or heading information (see 4.5.8.1and 4.5.8.3) and initiate markings, warnings and/or alarms according to 4.5.9 and 4.5.10.

6.2.4 Radar source

Means shall be taken to prevent the selection or warn the user, if the display scale of radar information is not appropriate for the source radar's transmitter/receiver settings.

If the radar image can be derived from different radar sources, the source radar must be indicated.

6.2.5 Presentation of different routes

If the displays of an INS can show different routes at the same time these shall be clearly marked to differentiate the one being used for actual navigation (the "active route") and the other(s), which are not, and with consistent markings regardless of the display on which they appear.

6.2.6 Presentation of trails and vectors or targets

All trails and vectors of targets on one display, regardless of their source, shall be presented using the same stabilisation and based on consistent settings.

6.3 Route planning

6.3.1 Route planning including straight and curved tracks

It shall be possible to carry out route planning including both straight and curved segments.

6.3.1.1 Navigation instructions

If a planned route includes information related to bridge procedures and/or the operation of the INS, these shall then be associated with the relevant waypoints or critical points (IMO NAV 48/19 Annex 10)

If the information includes the indication of relevant navigational zones or sub-zones unambiguous categories shall be used as applicable, for example:

- Sea passage;
- Coastal Waters (Pilotage waters, traffic separation zones, fairways, shallow waters);
- Narrow waters (rivers, canals, harbour areas).

The information may also include confirmable commands for changing into a defined mode of operation, display or control, including the suppression of certain audible signals for alarms and indications in a harbour area zone. See 4.12.3.

6.3.2 Adjustment to planned route

It shall be possible to adjust a planned route, for example, by:

a) adding waypoints to a route;

b) deleting waypoints from a route;

c) changing the position of a waypoint;

d) changing the order of the waypoints in the route.

(In case of INS(C) changes of waypoints in a selected route shall be limited, according to IEC 62065).

6.3.3 Alternate route planning

It shall be possible to plan an alternate route in addition to the selected route.

The selected route shall be clearly distinguishable from other routes

6.3.4 Route crossing own ship’s safety contour

A warning shall be given, at least before a route is activated as the selected route, if a planned route crosses own ship’s safety contour,

6.3.5 Route crossing a boundary

A warning shall be given, at least before a route is activated as the selected route, if a planned route crosses the boundary of a prohibited area or of a geographic area for which special conditions exist. (See IEC 61174, annex C.)

6.3.6 Cross track distance limit

The system shall provide a default symmetrical limit of deviation from the planned route at which an automatic cross track distance alarm shall occur . The default minimum limit shall be the ship's breadth plus the expected precision of the selected positioning system, see 4.5.9.1, If the route includes curved segments, the outline of the limits shall follow the curves equidistantly. It shall be possible for the mariner to specify a different limit of deviation from the planned route.

6.3.7 Checking for hazardous objects

The INS shall check the planned route within the specified limits of deviation, but at least within the minimum limit, for any objects contained in the chart database, or received from the connected AIS, that may be hazardous to safe navigation, e.g. safety contours, shallow spot depths, wrecks, bridges, etc.

At least whenever a route passing over/under such hazards is displayed as the "selected route", an appropriate warning shall be provided and indications of identified hazards shall at least be available upon request.

6.3.8 Warning for non availability of ENC for known hazards

If automatic checking the route for known hazards is not possible, or limited to manually entered safety lines, because a suitable ENC data base is not available for the actual area, a warning shall be given.

6.3.9 Chart data other than from ENC's

If the system is capable to display chart data other than from ENC's, it shall provide the function for manual entry of known hazards (taken from official charts), at least by the definition of manual safety lines, which are then also to be regarded by the checking functions as per 6.3.7.

6.3.10 Unsafe turning rate

If the route includes a curved segment with a radius that cannot be achieved with a safe turning rate at maximum ship's speed, the system shall request the input of a planned speed and shall provide a warning if the planned curve would result in an unsafe turning rate at the planned speed.

6.3.11 Early course change - indication

If the route includes a sequence of waypoints, the system shall automatically calculate or request the manual input of wheel-over-points for each required course change, at the latest at a time defined by the operator for an early course change indication. (In case of an INS (C) the system shall use the parameters for early course change indication and actual course change and confirmation, as required by IEC 62065)

6.3.12 Critical point

The INS shall permit the mariner to enter critical points on a route and the time or distance at which an alarm or warning shall be given, similar to the entry of waypoints.

6.4 Route monitoring

6.4.1 Automatic monitoring of primary navigation information

The INS shall be capable of automatically monitoring the primary navigation information together with the actual route and all known and detected hazards for display and for the generation of alarms and warnings, within limits set by the operator.

Note:a) Known hazards are, as a minimum, those contained in the ENC, if AIS is fitted, known hazards also include AIS reported fixed targets.

Note:b) Detected hazards are, as a minimum, all RP tracked targets normally used for collision avoidance, if AIS is fitted, detected hazards also include AIS reported floating targets.

6.4.2 Selected route

The selected route, manually entered safety lines and own ship's position shall appear whenever the display covers that area.

6.4.3 Temporary display without own ship's position

It shall be possible to temporarily display a sea area that does not have the own ship on the display (e.g. for look ahead, route planning) regardless of the mode of operation, display or control, except in a service mode. The automatic route monitoring functions (e.g. for updating ship’s position and providing alarms, warnings and indications) shall be continuous. It shall be possible to return to the route monitoring display covering own ship's position immediately by single operator action. (See 6.5.3)

6.4.4 Non-availability of appropriate ENC

If an appropriate ENC for the actual area being traversed is not available, the INS shall give a warning to inform the mariner that known hazards warnings or alarms may not automatically be generated.

6.4.5 Navigational alarms or warnings

The INS shall give an alarm or warning, as planned or selected and within a time or distance specified by the mariner, if the ship:

a) is going to cross the boundary of a prohibited area or of a geographic area for which special conditions exist. (See IEC 61174, annex C.), or

b) is going to reach (passing abeam of) a waypoint that includes navigation instructions (see 6.3.1.1), a critical point.

c) a point for early course change indication, or a wheel over line on the selected route.

In case of INS (C) these alarms and warnings shall conform to IEC 62065 for early course change and confirmable course change indications.

6.4.6 Navigational alarms

The INS shall give an alarm when:

a) the ship, within a specified time or distance set by the mariner, is going to cross the safety contour or a manual safety line, or

b) *the specified* cross track distance *limit for deviation from the planned route is exceeded,* or

c) a wheel-over-line will be reached within a time specified by the mariner and before the early course change indication (see 6.4.5) for this point has been acknowledged, (in case of INS (C) according to IEC 62065 as required for early course change and confirmable course change indications), or

d) a planned speed limit is exceeding or is falling below a planned (see 6.3.10) or pre-set limit, or

e) as specified in IEC 60872 for radar targets, and equivalent for AIS targets if AIS is installed, or

f) the depth received from the depth sounder is smaller than a depth limit specified by the mariner, or

g) the difference between the measured and charted depths is larger than a limit specified by the mariner, or

h) information from the devices for providing RP or AIS targets, depths or chart objects is not available.

6.4.7 Modified or alternative route

During the voyage, it shall be possible for the mariner to modify the selected route or select an alternative route.

6.5 Display of information and related controls

6.5.1 Display of essential information

As a minimum and in addition to the requirements for an INS (A), all of the following essential information shall be available at least at the workstation as per 6.1.1and be continuously displayed upon a single operator command, see also **Error! Reference source not found.**:

- Geographical display as per 6.1.1including the own ship's symbol and required display controls;
- The active route (within the display area);
- Planned (if relevant) and actual course over ground;
- Off course deviation and off track distance if an active route is selected;
- Panned (if relevant) and actual speed over ground and /or speed through water with drift angle, (the speed that is used for stabilisation of target vectors shall (additionally) be displayed).

The operator may deselect the following groups of information:

a) The chart background of the radar presentation, or

b) the radar overlay of the chart presentation, and/or

c) RP targets, and/or

d) AIS objects.

6.5.2 Display of supplementary information

6.5.2.1 Supplementary information for continuous display

After the display mode as per 6.5.1has been selected, any group of the following supplementary information shall, as a minimum, be available for continuous presentation at the same display upon single operator command, as relevant to the planned parameters and selected route. [All of the information shall be displayed when a point for early course change indication, or a wheel over line has been reached on the selected route.]

- Designation of the selected route, including designations of the "from" and "to" waypoints;

- Graphical indication of the track limits at the geographic presentation of the actual leg [(at least in a display range or scale where the availability of a scaled ship's symbol is required)];
- Time and distance to wheel-over;
- Planned and actual radius or rate of turn for the turn to the NEXT-leg;
- Planned course and speed for the NEXT-leg.

6.5.2.2 Other supplementary information

Any other supplementary information shall at least be displayed when so selected, e. g. navigational instructions that are part of route planning data.

6.5.2.3 AIS binary messages

Available information from AIS binary messages shall be presented at the INS workstation as per 6.1.1 upon operator selection (IMO NAV 48/19 Annex 11 clause 2.4.1). This message presentation need not be part of the INS.

6.5.3 Presentation of information including AIS and RP targets

6.5.3.1 Composite displays with chart objects

For displays providing the combined presentation of radar image, RP targets, AIS targets and/or chart objects the chart objects may temporarily (EG by spring-loaded or time-limited function) be presented in shades of grey

[Note: The workstation as per 6.1.1 shall, as default, display all targets reported from the connected RP(s) and AIS within the displayed area.]

6.5.3.2 Target identifier

For each target an unambiguous identifier shall be used for presentation on any INS display. Where targets from more than one source can be presented on one display the identifier may be amended as required. Amended target identifiers shall be used for all INS display presentations.

6.5.3.3 Combined radar signals

A display may present combined radar signals from more than one source providing, the operation and as far as reasonably practical, the malfunctions of this additional facility do not degrade the presentation of the radar source selected as primary. The primary and other source (s) shall be indicated as such.

Note: Such functions may deviate from International Standards for individual equipment. (see 4)

6.5.3.4 Graphical AIS target or merged target display

The INS shall be capable of displaying AIS targets graphically on the same display with radar video, at least at the INS workstation as per 6.1.1. AIS targets may be co-related or merged with their related RP targets. Merging can be manual and/or automatic.

6.5.3.5 Target selection or merging

An automatic or manual *display selection* or merging *function may be provided to avoid the presentation of two or more target symbols for the same physical target. If target data from AIS and from radar plotting functions are available, then the activated AIS target symbol shall be presented, if the automatic display selection criteria is fulfilled, otherwise the respective symbols shall be displayed separately. The operator shall have the option to make reasonable changes to the default parameters of automatic display selection criteria.* (C.217/2.2.6)**.**

Note: Selection or merging of targets shall not cause an alarm.

6.5.3.6 Common criteria for target related alarms

When target data has been selected or merged, common criteria shall be used for raising target related alarms, including CPA/TCPA, bow crossing, guard zone entry, lost target etc regardless of the source.

6.5.3.7 Accuracy of target presentation

Selection or merging of targets shall not degrade the accuracy of target presentation below that defined in the relevant radar performance standard.

6.5.3.8 Manual target selection for separate presentation

The INS may allow the operator to manually select merged targets for separate presentation or de-merging.

6.5.3.9 Automatic de-merging of targets

When targets no longer meet the merge criteria they shall be automatically de-merged and an alarm or warning shall be raised as selected by the mariner.

6.5.3.10 Lost target sensor data

When a merged target looses data from one of the sensors but data from other sensors is still available, no alarm shall be raised. The target shall become de-merged if data is only being received from a single sensor and an alarm or warning shall be raised as selected by the mariner.

6.5.3.11 Conditions and limitations of target merging

The general conditions under which target data from sensors are merged or de-merged and the limitations of the process shall be described in the operator's manual.

6.5.3.12 Target symbol

A single graphical symbol shall be used to represent target data merged from more than one sensor. Graphical symbols shall conform to those defined in IEC 62288 or until that standard is issued, IEC 60872-1 for radar and IMO S/N Circ. 217 for AIS targets. Merged targets shall be presented by the AIS symbol, which may be enhanced to indicate that more than one sensor provided data for this target.

6.5.3.13 Target data display

When a target is selected, the associated data display shall indicate the sources for this target and shall allow the operator to select the data display from each individual source. The data display shall meet the requirements of IEC 60872-1 if the target sources are radar, and shall additionally meet IMO SN / Circ.217 if one of the sources is AIS.

6.5.3.14 [Target overflow

When the maximum number of targets that can be processed by the INS is reached, the system shall apply an appropriate target priority management to ensure, that

a) the targets with most dangerous CPA/TCPA values,

b) those within defined area(s) of interest,

c) the closest targets

have preference before others.]

6.5.4 Defined display modes

It is recommended that the INS provides predefined or operator defined display modes, that are optimally suitable to combine the information related to zones according to the nature of navigation, see 6.3.1.1, e.g.

6.5.4.1 Man-over-board display

It is recommended that the INS provides a predefined display mode for a "man-over-board" situation, that can be accessed upon single operator command. In such case the display shall present the normal display used for route monitoring with a superimposed graphical presentation of a man-over-board-manoeuvre to the present or operator defined position and at a scale that allows the presentation of the complete manoeuvre pattern.

6.5.5 Operator controls and associated indicators

The controls and related displays for controlling the display functions, for selecting the active route and for entering the warning and alarm limits as per 6.3 and 6.4 shall be available at least at the workstation as per 6.1.1.

7 Requirements applicable to INS(C)

The INS(C) shall, in addition to the functional requirements of INS(B), provide means to automatically control heading, track or speed and monitor the performance and status of these controls (MSC 86(70), 4.1.9) as follows:[

a) For the purpose of automatic heading control on single straight segments and with operator confirmed single heading commands, the INS (C) shall include or be connected to a heading control system complying with ISO 11674.
b) In case of automatic heading or track control on a series of route segments or in case of automatic speed control, the INS shall include or be connected to a track control system complying with IEC 62065.
c) The installation manual shall include appropriate details about safe connections to approved heading and/or track control systems and/or to rudder and/or propulsion control devices.

A connected heading or track control system, or Dynamic Positioning System (DPS), type approved according to the relevant International Standards, does not form part of the INS, if it is not required for functions of the INS other than control functions complying with its individual International Standard.]

7.1 [Consistency of route planning and control functions

If the connected or integrated heading, track or speed control system cannot execute the route as planned, e.g.

- does not at least include the "assisted turn control functions" as per IEC 62065 although turns have been planned,
- includes a turn that is smaller or larger than the control capability,
- includes a planned speed that is lower or higher than the control capability,

a warning shall be indicated at least when such route is displayed as the "selected route" and such route shall not be useable for automatic track control.]

7.2 Recording function

7.2.1 Recording functions additional to those required for ECDIS

The INS (C) shall include a recording function as required for ECDIS (see IEC 61174), and

- when in an active control mode the information of heading, speed and rudder angle shall additionally be recorded at intervals of not more than 10 seconds,

and the recording shall additionally include the following time marked information:

- integrity status of position, heading and speed, and changes thereof,
- activation/de-activation of an automatic control mode, with
- next waypoint, set heading, set course or set speed, as relevant

7.2.2 Internal or external recording function

Providing the recording function may be an extended function of a connected or integrated ECDIS or Voyage Data Recorder. If an external function, necessary details for the required recording equipment and connections to it shall be included in the installation manual.

7.3 Automatic monitoring functions

7.3.1 Required indication, warning and alarm functions

All required indication, warning and alarm functions and their controls as relevant for the connected or integrated control system (see 7.1) shall be available at least at the workstation as per 6.1.1.

7.3.2 Different monitoring, indication, warning or alarm limits

Where different monitoring, indication, warning or alarm limits for connected sensors are in effect for the INS and the connected control equipment, the stricter limit shall be used. The system and the connected control equipment shall not generate multiple alarms for an equivalent cause.

7.3.3 Warning for different sources

In case of a connected heading, track or speed control system, the INS shall raise a warning if the control system uses different sources for heading, course, speed, position, waypoints or routes than that selected for the INS, see 4.5. If different sensors for heading are used by the installed system configuration (see note to 7.6.1), relevant details shall be included in the operational manual.

7.4 Display of information for INS (C)

7.4.1 Display of essential information

In addition to the requirements for an INS (B) and to the requirements for an integrated or connected heading, track or speed control system, the following essential information, as relevant for the selected control mode, shall be available for continuous display at the workstation as per 6.1.1, at least upon a single operator command, but shall in any case be presented before an automatic control mode can be activated or changed:

- the active mode of steering or speed control
- time and distance to wheel-over, at least after the relevant limit for early course change indication has been reached
- set and actual radius or rate of turn to the next segment, if the route includes a curved segment or in case of a track control system of category B
- rudder angle, propulsion data - e.g. power, propeller pitch, as relevant *)

Note: The information marked with *) must not necessarily be presented on a display of the INS workstation, but shall be easily readable from there. In such case the installation manual shall include the necessary details.

7.4.2 Optional conning display

The data as per 7.4.1 together with the primary navigation information and supplementary information may commonly be presented at a separate display (typically called "Conning Display"). In such case information such as:

- speed,
- heading,
- rate of turn,
- rudder angle, and
- propulsion data

shall be presented together with their "set- values" in analogue form, e.g. mimic elements, logically arranged on and around a symbolic outline of a ship.

7.4.3 Display of supplementary information

Supplementary information including all other user settable limits and pre-set control parameters related to automatic control functions shall be displayable on demand.

7.5 Operator control and display functions

At least the Workstation as per 6.1.1 for INS(C) shall include all controls and status indicators required for terminating or interrupting the heading, track or speed control mode by a single operator action, which may be components of a Heading, Speed, or Track Control System forming part of the INS or to which the INS is connected. In case of multiple workstations with such controls, only one workstation shall at any time be ready to accept control commands. It shall clearly be indicated, if not otherwise obvious, if a workstation is not readily set to accept control commands, at least upon an attempt to access control. If a workstation includes such controls, taking command shall be a confirmable function of this workstation and it shall not be possible to block it from another workstation.

7.6 Heading, track or speed control

7.6.1 Automatic control functions

The INS shall provide the following functions for automatic heading, track or speed control, based on routes only if these have been checked for known hazards as per 6.3.4, 6.3.5, and 6.3.7 according to the requirements of the appropriate International Standard as relevant (see 7) and:

- transfer the system position and system speed data, and if appropriate also the heading data (Note x1), to a connected or integrated heading, track or speed control system, and
- transfer the selected route or parts thereof and or set heading, set course or set speed commands to a connected or integrated heading, track or speed control system, or
- transfer steering and/or speed control commands to the ship’s manoeuvring system where the control functions are integrated in the INS.

Note: Connected heading, track or speed control systems shall use the system position and system speed from the INS, as required, but may be directly connected to the required heading sensor(s) for optimal steering control

7.6.2 Prevailing control limits

In case of different control limits being set in the INS and in a connected heading, track or speed control system, the latter shall prevail for the control process. For monitoring, alarms and indications, the stricter limits shall be used. (see 7.3.2 and Note below)

Note: Typically, wider steering limits are set in equipment for direct steering control, to allow for emergency manoeuvres, whereas stricter limits may be used in the INS for navigation monitoring, also considering economy, cargo or passenger comfort.

7.6.3 Manual override facilities

The INS (C) shall be connected to a heading, track or speed control system in such a way, that any operation of a manual override control immediately overrides the automatic control functions, regardless of the setting of any mode or selector switch and regardless of any failure in the INS.

7.7 Automatic speed control

If functions for automatic speed control are provided, these shall only be available in the active track mode of a connected or integrated track control system, see 7, and shall additionally comply with the following requirements:

7.7.1 Connection to a propulsion control system

If the speed control function is integrated in the INS, then the INS shall be connected to the propulsion control system of the ship in such a way, that any operation of the main manual control for the ship's speed immediately overrides the automatic speed control, regardless of the setting of any mode or selector switch and regardless of any failure in the INS.

The installation manual shall include appropriate details about safe connections to supported propulsion control systems.

7.7.2 Indication of speed settings

If the automatic speed control is active, the lever(s) or the set speed indicators for manual speed control, as relevant, at least at the conning position, shall indicate or automatically be moved according to the automatic speed settings shall indicate the automatic speed settings or be automatically moved accordingly.

7.7.3 Speed control mode selector switch

If a speed control mode selector switch or manual override facility is available, this shall be installed adjacent to the manual speed control(s), at least at the conning position. This requirement shall be included in the installation manual.

7.8 Reversionary mode

The INS shall *allow simple and effective operator action to override or by-pass any automated functions.* These override or by-pass functions may be provided by separate parts of the ship’s manoeuvring equipment or of a connected heading, track or speed control system and must conform to the individual International Standards as well as to the requirements as per 7.6.3, 7.7.1, and 7.7.3. The installation and operating manuals shall include a functional description and the necessary details for correct interfacing to the external override or the bypassing devices.

After a control mode has been terminated or changed to another mode *the INS* shall *resume automatic functions only after an appropriate message and intended operator action,* i.e. operator confirmation of the command, thus allowing the operator the opportunity *of considering all necessary starting conditions.* (MSC 86(70), 4.3.2)

8 Test requirements and results

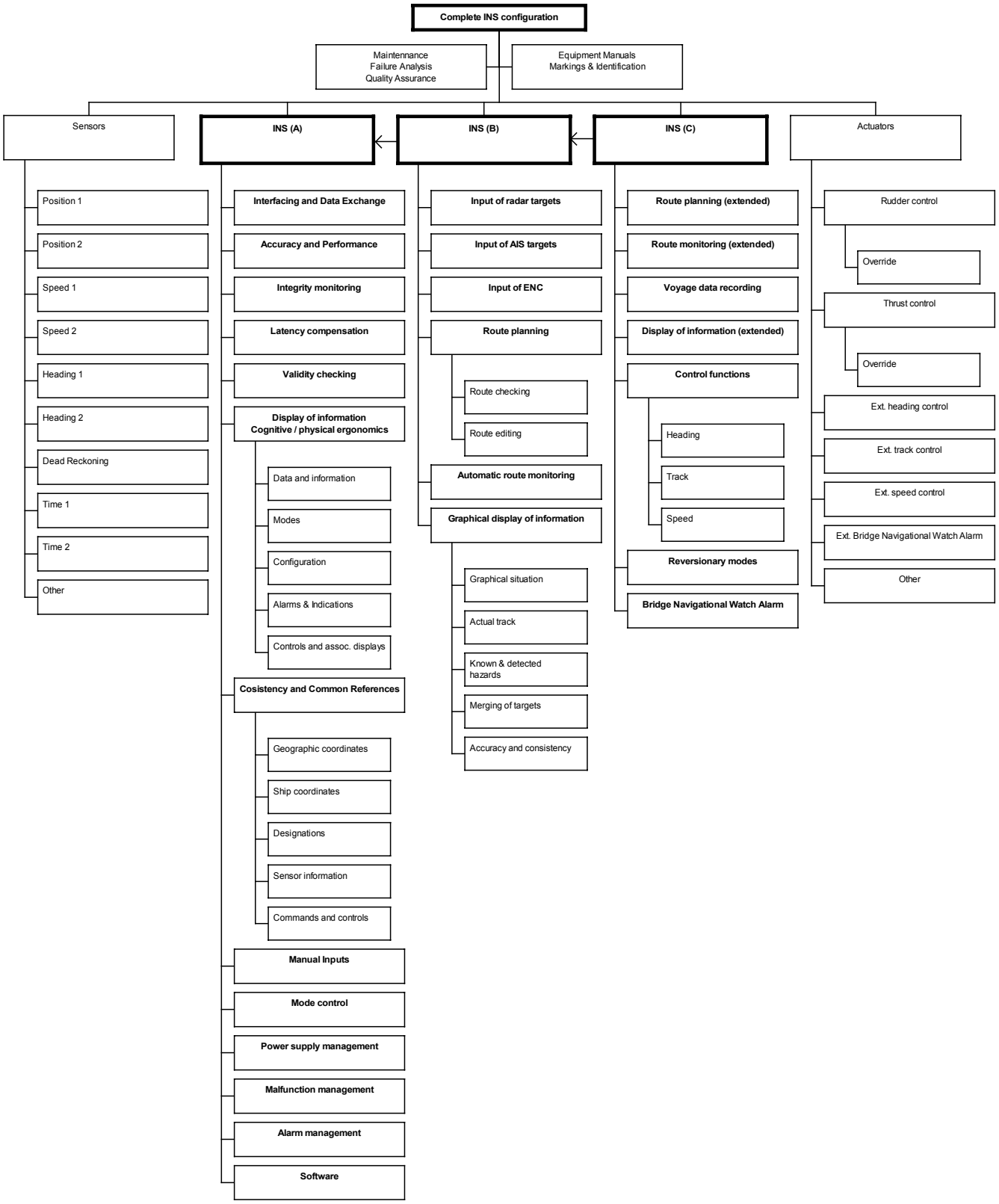
To be further developed following receipt of comments on CD draft revision 13.0.

(8.1 – 8.2 : take from IEC 62065, 5 – 5.2, replace T.C.S. by INS)

8.1 Identification of the equipment under test (EUT)

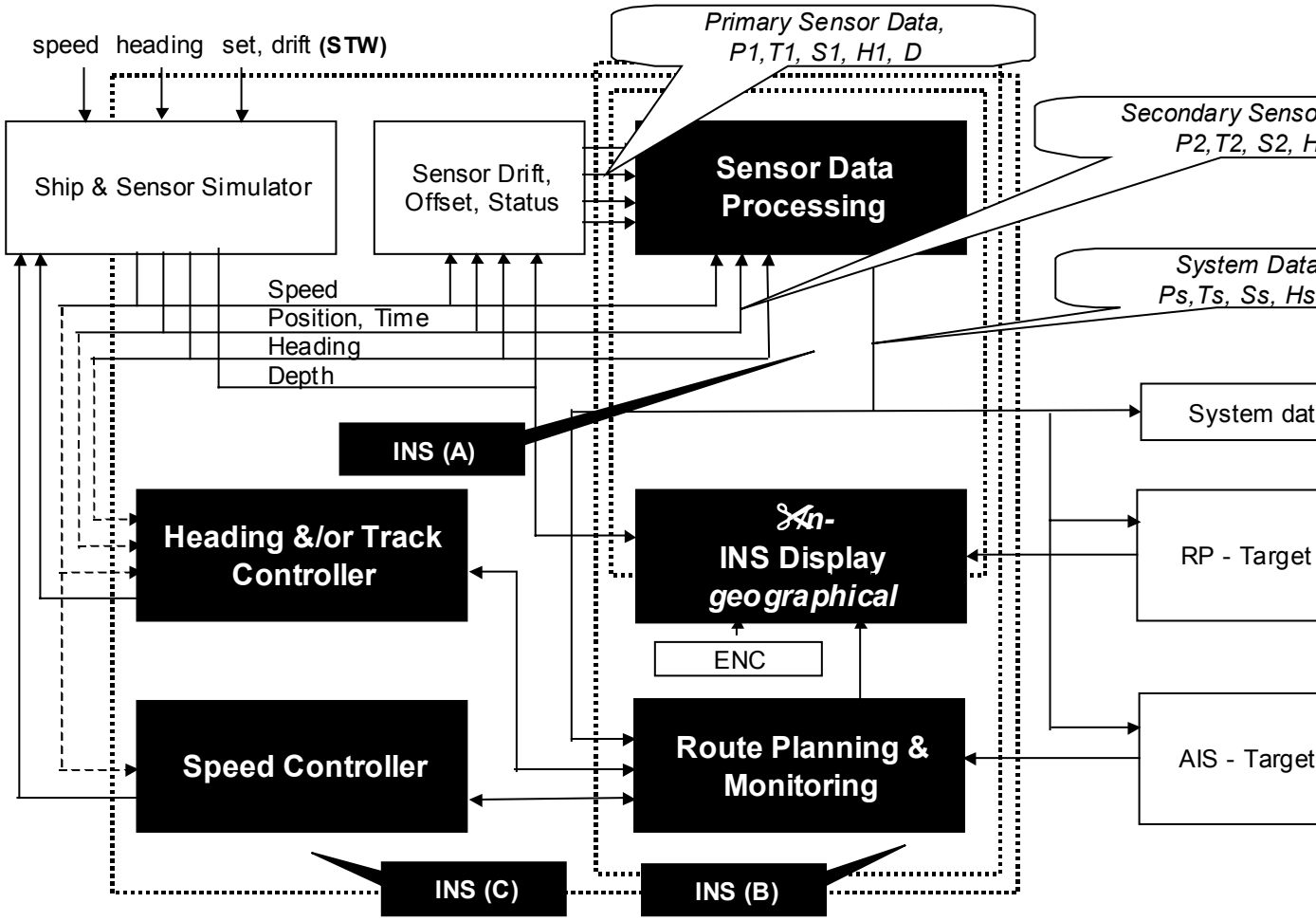
Identification of functions can be taken from the following functional model of an INS, with the relevant test(s) indicated in ( ) :

Functional model of an Integrated Navigation System (INS)



8.2 Set-up of the test environment

Prepare the test environment (see block diagram next page) including necessary simulators and install the interfaces to the EUT. Prepare the scenarios by loading the test tracks into the planning system that is used by the EUT, or in case of INS (A), follow the track of scenario 1 manually by means of controlling speed and heading at the simulator.



Block Diagram of the INS test environment

8.2.1 Simulators

All functional tests of the INS shall be performed using appropriate simulators for the motion of a ship, the input of sensor data including settings for typical sensor behaviour, and additional simulator(s) for inputting of radar and AIS targets in case of INS (B).

a) The ship motion simulator should at least be capable to generate the primary navigation data from an initial ship's position, and shall provide changes of these data consequential to manual variations of speed and heading.

b) The ship motion simulator shall be capable of updating the output data at a rate of not less than 1 Hz for position and speed, and not less than 10 Hz for heading and time. The output of depth may be a simple sinusoidal variation of a fixed manual input value. In case of an INS (C), the ship motion simulator shall additionally be capable to fulfil the requirements of IEC 62065, 5.2.1.

c) The output data of position shall be modulated with data noise according to Annex (H of IEC 62065), including consequentially modulating speed and heading data.

d) The simulation environment shall be capable of separately modifying primary sensor data upon manual input of sensor drift and offset values and setting of status parameters, individually for each input of primary sensor data.

e) The resolution and accuracy of the simulated signals shall be in accordance with the applicable IMO, IEC and ISO requirements and as specified in table section 4.6. The output signals shall comply with IEC 61162 and with the types of interfaces supported by the EUT according to the manufacturers declarations (4.5.1, 4.6.).

8.2.2 Test Scenarios

a) The scenarios as per ANNEX (ex IEC 62065 Annex G) shall be used for testing the EUT as follows:

- Scenario 1 – to be manually or automatically executed for INS (A), and manually for INS (B), by means of the simulator;
- Scenario 4 – for INS (B), to be manually or automatically executed by means of the simulator;

All scenarios for INS (C), to be automatically executed by the INS (C).

b) Additional scenario 5: A scenario which covers a defined passage across the ENC. A track shall be planned and followed, which covers a passage across the ENC with a depth profile partly infringing the set safety depth of the ship, and with known hazards of surface and subsurface objects along the track.

8.3 Execution of performance tests and related checks

8.3.1 Sensor Monitoring Functions

Load Scenario 1 into the simulator and generate all sensor signals as supported by the EUT

8.3.1.1 Check that all data are displayed as required by 4.11:

a) As commanded by controls at the same workstation where the data are displayed (4.11.9);

b) At a display designated as part of the INS (4.11.1);

c) Including sensor data as well as information generated by the INS (4.11.2), and as per:

   1) 4.11.4 for INS (A), and

   2) 6.4.1 for INS (B), and

   3) 7.5.1 for INS (C);

d) Optimised for good readability and complete (4.11.3, .4, .5, .6, and 4.17.2.1);

e) With other information not obscuring the required data (4.11.8);

f) Conforming to the requirements for resolution (4.6.2);

g) Referring to only one location on the ship (4.7.1);

h) Using the same units of measurement throughout (4.7.1);

i) Corresponding to the data being simulated, including correct signs and directions when passing 0-degrees of Lat/Lon, (4.7.2, .3, .4);

j) With primary data at intervals of no more than 1 sec and time-synchronous by 0,1 sec (4.7.5). (In case of doubt, this check may be performed with the aid of a camera and monitor with single frame replay capability).

8.3.1.2 Testing the integrity of data and information

Testing the integrity of data and information as required by 4.8, 4.9 and 4.10 including the display of related alarms and messages:

For these tests, the simulator shall be used to generate primary sensor signals with modified properties of drift, offset and status information and to generate secondary sensor signals corresponding to the unmodified primary sensor signals. The secondary sensor signals

supplied shall comply with the capabilities of the EUT according to the manufacturers declarations and technical documentation, and at least with the minimum requirements of 4.8.2 including 4.8.2.9. and .10. The test shall be repeated

- For each sensor which can be connected and set for providing primary navigation data,
- For the smallest and the largest value of the alarm limits (if these can be set by the operator),
- For all independent validity status indications of the primary and secondary sensors, and
- For each type of secondary sensor data the system is capable to use for the integrity monitoring.

After each test the appropriate indications of alarms and warnings shall be checked, before normal operation conditions are to be re-established for the EUT:

a) Check that the EUT does not generate false alarms or indications when the corresponding limits are not exceeded (4.15.4) and that essential information successfully checked for integrity is marked valid (4.8.2.14);

b) Check that the system generates a warning indication in case it has no secondary sensor information or automatically has switched to alternative secondary sensor information for integrity monitoring which has not yet confirmed the integrity of the primary sensor (4.8.2.5, .12);

c) Check that the EUT generates the appropriate marking of data and warning indication when 50% of the corresponding limit is exceeded or integrity checking is not possible, and generating the alarm with appropriate message when 100% of the corresponding limit is exceeded, or data of a selected primary sensor is not available or corrupted, and that the conditions for generating alarms and messages correspond to the descriptions in the operating manual (4.5.3, 4.8.2.6, .7, 12, 13, 4.11.7, 4.15.);

d) Check that an alarm is automatically accompanied by an alarm message according to 4.15.5 and .6, and that appropriate messages are available and displayed upon request for active alarms and for warnings (4.15.1, .2), and that alarms, warnings and indications are meeting the requirements of 4.15.3;

e) Check that functions independent from the invalid data are not affected (4.5.3);

f) Check that the acknowledgement and cancellation of alarms meets the requirements of 4.8.2.12, 4.15.4 and 4.15.7;

g) Check that the operator is requested to input drift and set values in case the integrity check uses information from an STW-sensor (4.8.2.8);

h) Check that any information is marked with an indication of “active alarm” if its source of sensor data has been designated as invalid, and that an alarm is only generated in case of primary navigation data (4.8.2.12, 4.15.4);

i) Check that the acknowledgement of alarms and the change of the status of information is indicated as per 4.8.2.12 and 4.15;

j) In case required sensor monitoring functions are part of a sensor, check that this is declared as part of the INS and details are included in the installation manuals (4.8.2.15). In such case the performance tests for this sensor according to its individual technical standard shall be extended by the testing procedures of this section 8.3.1.2 as applicable (4.8.2.16).

8.3.1.3 Testing the latency and validity of data as required by 4.9 and 4.10

These tests may be combined with the tests as per 8.3.1.2 and shall be performed at full speed and during turns.

Connect (an) appropriate monitor(s) to the internal and external connections for system data and check the latency and validity markings. (In case of doubt, these checks may be performed with the aid of a camera and monitor with single frame replay capability, with the data display of the sensor simulator in view together with the INS display and/or the display of the system data monitor):

- Check that the latency between data and information of the same source(s) between the displays does not exceed 2 sec, regardless of the executed part of the scenario and regardless of the type of information, except for alarms and for validity designator(s) of system data (4.9.1, .2, .3)
- Check that the system data does not deviate from the simulated sensor data by more than the accuracy specified in the individual international standards for the given type of sensor. (in case of doubt a processor shall be connected to both the input and output interfaces of the INS sensor processor(s) for appropriate calculations of the deviations (4.9.3)
- Check that the validity designator(s) of the distributed data are always present (if the data is present) and that a delay of indicating a change of validity status does not exceed the set or specified limits (4.8.2.6, 4.10.1, .2).

8.3.2 Testing the route planning and monitoring performance for INS (B)

The Scenarios 1, 4 and 5 shall be created by the route planning functions of INS (B)

8.3.2.1 Route planning

Select the planning mode with an appropriate chart display

- Enter and store the waypoints of the test scenarios with their co-ordinates and designations
- Select the waypoints for the tracks of the scenarios, assign the track designations (“Scenario 1”, “..4”, “..5”), enter appropriate track limits, enter all additional information and manoeuvring limits as per the operating manual, store the tracks

Enter appropriate warning and alarm limits for known and detected hazards

ANNEX A
(Normative)

IMO Resolution MSC 86(70)

(adopted on 8 December 1998)

Adoption of new and amended performance standards for navigation equipment

THE MARITIME SAFETY COMMITTEE,

RECALLING Article 28(b) of the Convention on the International Maritime Organization concerning the functions of the Committee,

RECALLING ALSO resolution A.825(19), by which the Assembly resolved that the functions of adopting performance standards for radio and navigational equipment, as well as amendments thereto, shall be performed by the Maritime Safety Committee on behalf of the Organization,

HAVING CONSIDERED new performance standards and amendments to existing performance standards adopted by the Assembly and prepared by the forty-fourth session of the Sub-Committee on Safety of Navigation,

1. ADOPTS the following new recommended performance standards, set out in Annexes 1 to 3 to the present resolution:

.1 Recommendation on Performance Standards for Sound Reception Systems (Annex 1);

.2 Recommendation on Performance Standards for Marine Transmitting Magnetic Heading Devices (TMHDs) (Annex 2); and

.3 Recommendation on Performance Standards for an Integrated Navigation System (Annex 3);

2. ADOPTS ALSO the amendments to the Recommendation on Performance Standards for Electronic Chart Display and Information Systems (ECDISs) (resolution A.817(19)) set out in Annex 4 to the present resolution;

3. RECOMMENDS Member Governments to ensure that:

.1 sound reception systems, marine transmitting heading devices and integrated navigation systems installed on or after 1 January 2000 conform to performance standards not inferior to those set out in Annexes 1 to 3 to the present resolution;

.2 ECDIS installed on or after 1 January 2000 conform, respectively, to performance standards not inferior to those set out in resolution A.817(19), as amended, and Annex 4 to the present resolution;

.3 ECDIS installed on 1 January 1999 and before 1 January 2000 conform at least to the performance standards set out in resolution A.817(19), as amended by resolution MSC.64(67), Annex 5; and

.4 ECDIS installed before 1 January 1999 conform at least to performance standards set out in resolution A.817(19).

Annex 3

RECOMMENDATION ON PERFORMANCE STANDARDS FOR AN INTEGRATED NAVIGATION SYSTEM (INS)

1 SCOPE

1.1 The purpose of an integrated navigation system (INS) is to provide 'added value' to the functions and information needed by the officer in charge of the navigational watch (00W) to plan, monitor or control the progress of the ship.

1.2 The INS supports mode and situation awareness.

1.3 The INS supports safety of navigation by evaluating inputs from several independent and different sensors, combining them to provide information giving timely warnings of potential dangers and degradation of integrity of this information. Integrity monitoring is an intrinsic function of the INS.

1.4 The INS aims to ensure that, by taking human factors into consideration, the workload is kept within the capacity of the 00W in order to enhance safe and expeditious navigation and to complement the mariner's capabilities, while at the same time to compensate for their limitations.

1.5 The function of passage execution in an Integrated Bridge System (IBS), as defined by the Organisation* may be performed by an INS.

2 APPLICATION

2.1 These performance standards are applicable to any combination of navigational aids that provides functions beyond the general intent defined in the respective performance standards adopted by the Organisation for individual equipment.

2.2 The purpose of these performance standards is to support the proper and safe integration of navigational equipment and information.

2.3 These performance standards define three categories of INS:

.1 INS(A) for systems that provide the minimum functional requirements of the INS including a consistent common reference system;
.2 INS(B) for systems that, in addition to the' functional requirements of INS(A), provide the information needed for decision support in avoiding hazards; and
.3 INS(C) for systems that, in addition to the functional requirements of INS(B), provide the automatic control functions of heading, track or speed.

3 DEFINITIONS

For the purpose of these standards the following definitions apply.

3.1 **Automatic control system** - A control system that may include a heading, track or speed control system.

3.2 **Consistent common reference system** - A sub-system of an INS for acquisition, processing, storage and distribution of data and information providing identical and obligatory reference to sub-systems within an INS.

3.3 **Integrated navigation system** - An INS is a combination of systems that are interconnected to increase safe and efficient navigation by suitably qualified personnel.

3.4 **Integrity** - Ability of the system to provide the user with information within the specified accuracy in a timely, complete and unambiguous manner, and alarms and

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* Resolution MSC.64(67), Annex 1 - Recommendation on performance standards for Integrated Bridge Systems

indications within a specified time when the system should be used with caution or not at all.

3.5 **Multifunction display** - A single visual display unit that can present, either simultaneously or through a series of selectable pages, information from more than one operation of a system.

3.6 **Sensor** - A navigational aid, with or without its own display and control as appropriate, automatically providing information to the INS.

4 OPERATIONAL REQUIREMENTS

4.1 Functionality

General

4.1.1 In addition to meeting the relevant requirements of resolution A.694(17) *, the INS should comply with the requirements of these performance standards.

4.1.2 Each part of the INS should comply with all applicable requirements adopted by the Organisation, including the requirements of these performance standards. Parts executing multiple operations should meet the requirements specified for each individual function they can control, monitor or perform.

4.1.3 When functions of equipment connected to the INS provide facilities in addition to these performance standards, the operation and, as far as is reasonably practicable, the malfunction of such additional facilities should not degrade the performance of the INS below the requirements of these standards.

4.1.4 A failure of one part should not affect other parts except for those functions directly dependent upon the information from the defective part.

Basic functions

4.1.5 An INS should combine, process and evaluate data from all sensors in use. The integrity of data from different sensors should be evaluated prior to distribution.

4.1.6 An INS should ensure that the different types of information are distributed to the relevant parts of the system, applying a 'consistent common reference system' for all types of information.

4.1.7 The INS(A) should as a minimum provide the information of position, speed, heading and time, each clearly marked with an indication of integrity.

4.1.8 The INS(B) should be able to automatically, continually and graphically indicate the ship's position, speed and heading and, where available, depth in relation to the planned route as well as to known and detected hazards.

4.1.9 The INS(C) should, in addition, provide means to automatically control heading, track or speed and monitor the performance and status of these controls.

Integrity monitoring

4.1.10 The integrity of information should be verified by comparison of the data derived independently from two or more sources if available.

4.1.11 The integrity should be verified before essential information is displayed or used. Information with doubtful integrity should be clearly marked by the INS and should not be used for automatic control systems.

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* See also IEC Publication 60945

Data exchange

4.1.12 Stand-alone equipment for which performance standards adopted by the Organisation exist, when connected to the INS, should comply with the applicable international standards* for data exchange and interfacing.

4.1.13 Data latency should be consistent with the data requirements of the individual parts.

4.1.14 The integrity of data exchange within the INS should be ensured.

4.1.15 A failure of data exchange should not affect any independent functionality.

Integration

4.1.16 The INS should provide functional integration meeting the following requirements:
.1 where a display or control is presented on a multifunction display unit then these should be redundantly available; and
.2 validity* of the data should be provided for each part to be integrated.

Configuration control

4.1.17 It should be possible to display the complete system configuration, the available configuration and the configuration in use.

4.2 Information and accuracy

Display of information

4.2.1 The INS should be able to display the information available in accordance with paragraphs 4.1.7, 4.1.8 and 4.1.9 as applicable.

4.2.2 The INS should be capable of displaying output data available from the sensors.

4.2.3 The information should be displayed together with the indication of its source (sensor data, result of calculation or manual input), unit of measurement and status, including mode (see sub-section Integrity monitoring).

Accuracy

4.2.4 As a minimum, the accuracy of information should meet the requirements of the resolutions* adopted by the Organisation. Additionally the INS should not degrade the accuracy of the data provided by the sensors.

4.3 Malfunctions, alarms and indications

Fail safe operation

4.3.1 The system's automatic response to malfunctions should result in the safest of any other configuration accompanied by clear indications and alarms.

Reversionary mode

4.3.2 The INS should allow simple and effective operator action to override or by-pass any automated functions. The INS should resume automatic functions only after an appropriate message and intended operator action, considering all necessary starting conditions.

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* IEC Publication 61162

* Resolutions A.529(13) and A.815(19)

Alarm management

4.3.3 An alarm management system should be provided.

4.3.4 The INS alarm management system, as a minimum, should comply with the requirements of the Organisation.*

4.3.5 The number of alarms should be kept as low as possible by providing indications for information of lower importance.

4.3.6 Alarms should be displayed so that the alarm reason and the resulting functional restrictions can be easily understood. Indications should be self-explanatory.

5 ERGONOMIC CRITERIA

5.1 Cognitive ergonomics

5.1.1 Integrated display and control functions should adopt a consistent human machine interface (HMI) philosophy and implementation.

5.1.2 The HMI should be so designed that the provided information is clearly understood using a consistent presentation style.

5.1.3 The HMI should be so designed that the requested manual inputs can be easily executed.

5.1.4 For manual inputs that may cause unintended results, the INS should request confirmation before acceptance, thus providing a plausibility check.

5.2 Physical ergonomics

Controls and displays

5.2.1 Particular consideration should be given to:

- symbols;
- controls; and
- layout.

Operational controls

5.2.2 The INS should be designed and implemented so that the OoW easily operates basic functions from INS workstations.

Presentation of information

5.2.3 Continuously displayed information should be optimised and should include position, speed, heading and time. Supplementary information should be readily accessible.

6 DESIGN AND INSTALLATION

General

6.1 The INS should meet the relevant requirements of resolution A.694(17) and appropriate international standards*.

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* Resolution A.830(19)

* IEC Publication 60945

** See also IEC Publication 61508

Failure analysis

6.2 A failure analysis** should be performed and documented for the installed configuration of the INS which includes all parts connected to or integrated into the system, including devices for manual override of automatic functions and their locations on the bridge.

Installation requirements

6.3 The INS should be installed so that it can meet the requirements of the relevant International Standards.***

Power supply requirements

6.4 Power supply requirements applying to parts of the INS as a result of other IMO requirements should remain applicable.

6.5 The INS should be supplied:
- .1 from both the main and the emergency source of electrical power with automated changeover through a local distribution board with provision to preclude inadvertent shutdown; and
- .2 from a transitional source of electrical power for a duration of not less than 45 s.

Power interruptions and shutdown

6.6 After a power interruption full functionality of the INS should be available after recovery of all subsystems. The INS should not increase the recovery time of individual subsystem functions after power restoration.

6.7 If subjected to a power interruption the INS should, upon restoration of power, maintain the configuration in use and continue automated operation, as far as practicable. Safety related automatic functions, should only be restored upon confirmation by the operator.

7 INTERFACING

Interfacing to, and from, the INS should comply with international standards*, as appropriate.

8 FALL-BACK ARRANGEMENTS

8.1 The INS should, after a failure, support the availability of essential information through the use of appropriate fallback arrangements.

8.2 Normal operation, after use of a fallback arrangement, should only be restored upon confirmation by the operator.

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*** IEC Publications 92-101 and 533

* IEC Publication 61162

Annex B
(Informative)
Clarification of applications of this International Standard.

B.1 General

B.1.1 Difference to other IMO performance standards

The Performance Standard for Integrated Navigation Systems is different from many other IMO Performance Standards. Most performance standards address one specific type of equipment. When information from other equipment is needed, little more is stated as a requirement than specifying the data and interface used. Performance Standards for individual equipment typically do not adequately address the requirements for functions that may result from combinations with other equipment, namely the integrity, consistency and validity of information provided by their combination.

B.1.2 General applicability clause

The main clause stating the applicability of the Performance Standard for INS is clause 2.1 of MSC 86(70):

"*These performance standards are applicable to any combination of navigational aids that provides functions beyond the general intent defined in the respective performance standards adopted by the Organisation for individual equipment.*"

Therefore: If functions provided by combining equipment are not in the general intent of an IMO performance standard[1] of the relevant individual equipment, that means if these are not even implicitly included, then such combined equipment is an INS to which this international standard applies.

[1]The Footnote1 of 1.1 of this International Standard indicates, that the clarification of the "general intent" of a navigational aid should be specifically extracted from the relevant IMO Performance Standard or, in case of doubt, may be taken from other relevant IMO supplementary documents and/or from the minimum requirements of the appropriate IEC/ISO standards.

B.1.3 Minimum requirements

However, as all IMO Performance Standards are only specifying "minimum requirements" and purposefully leave room for innovations as long as these do not contradict the purpose of relevant requirements, additional functions of a navigational aid beyond the specified requirements do not automatically classify this as an INS.

B.1.4 Implicit applicability

On the other side, the pure existence of this IMO Performance Standard for INS implies that functions performed by a combination of navigational aids beyond their individual Performance Standards, which are explicitly described as basic functions of INS (A), (B) or (C) in IMO MSC 86(70) Annex 3, 2.3 and 4.1.7, .8 and .9 , are indeed classifying this as an INS.

B.1.5 Applicability for equipment for which no specific performance standards exist

The INS Standard may also be applicable for equipment, for which no individual IMO Performance Standard exists, if this performs basic functions of an INS. Basis for this consideration is SOLAS Ch.V, Regulation 18, 7:

"*When equipment, for which performance standards have been developed by the Organization, is carried on ships in addition to those items of equipment required by regulations 19 and 20, such equipment shall be subject to approval and shall as far as practicable comply with performance standards not inferior to those adopted by the Organisation."*

B.1.6 Ambiguous requirements for INS and for ECDIS with radar

There are two navigational aids for which IMO Performance Standards exist, namely

- ECDIS with superimposition of a radar image, (IMO Resolution A.817 (19) (Annex 5, section 6.3), and
- Radar with superimposition of chart information, (IMO Resolution A.447 (XII) (Annex 4, sections 3.3.9 and 3.3.10),

which must be considered in combination with

- MSC SN / Circ. 217, "Interim Guidelines for the presentation and display of AIS target information".

Navigational Aids conforming to these standards are obviously integrating information from several sources for "known and detected hazards" and, although these are practically fulfilling the basic functions of an INS (B), formally need not to conform with the IMO performance standard for INS (B).

The reason is, that such combinations of navigational aids need not provide "functions beyond the … intent" for presenting information equivalent to an INS (B). The problem is: Both the individual standards for ECDIS and radar do not state sufficient requirements for the integrity, consistency and validity of information for the combined configuration, so that information displayed on the two individual displays, or combined on one display, may deviate from each other or even contradict and may thus lead to compromised navigational safety.

B.1.7 State of the art

Manufacturers and test houses are therefore advised, that this technical standard describes the state of the art for the integration of information from different Navigational Aids, and should therefore be used for the design and testing of relevant functions including Navigational Aids which formally do not need to comply with the requirements for INS.

B.2 Examples:

As the wording *"...provides functions beyond the general intent defined in the respective performance standards adopted by the Organisation for individual equipment…"* (IMO MSC 86(70), Annex 3 (INS), 2.1) is critical to the understanding of the applicability of this standard, some examples are given here, for assistance:

B.2.1 Heading control system (HCS or Autopilot) combined with navigational aids such as GPS, ECDIS, etc.

The combination of an HCS (that is not part of a track control system, for such case see B.2.2) with other navigational aids such as an Electronic Position Fixing System, Radar or ECDIS, **is an INS(C),** when this combination provides functions for controlling the ship's movement automatically along waypoints or by "set-heading"-commands which need not be individually confirmed by the operator. Such system must comply with the requirements for an INS (C) because the combination of the equipment provides functions, in this case track control functions, which are not included in the respective IMO performance standard for an HCS. For example:

The data supplied by a GPS receiver may contain standardised data sentences APA, APB and/or HSC for controlling an autopilot in a non-SOLAS vessel. Although the IMO Performance Standard for GPS itself does not require this function, the GPS receiver may have been type approved as EPFS, because the additional functionality, in the given case, was not relevant nor prohibitive for the receiver to operate as an EPFS.

The IMO Performance Standard for HCS does not mention any automatic input of the "heading to steer“. It is however a significant function beyond the general intent of an HCS, when the "heading to steer" is remotely controlled from another equipment or when the heading controller includes a function to accept waypoints for calculating the "course to steer" automatically.

Because such additional function is the result of the combination of the equipment, the INS performance standard must be applied.

However: When a radar or ECDIS is connected to an HCS and one of its functions (e.g. the EBL) is used to transfer the "course to steer", this does not constitute an INS(C) if this input is displayed at the control panel of the HCS and must manually be confirmed at the HCS before becoming effective. The reason is, that the function to input a single "course to steer" is included in the performance standard of the Heading Control System, and the fact that a radar is used to provide the input to the HCS is not a significant deviation from the general intent of an HCS if each input value must still be confirmed by the operator before becoming effective.

B.2.2 Track Control Systems (TCS) combined with navigational aids such as GPS, ECDIS, etc. for the exchange of waypoint data

The combination of a TCS with other navigational aids such as an Electronic Position Fixing System, Radar or ECDIS, for the input or exchange of waypoint data, **is an INS(C)**. The IMO Performance Standard for TCS does not include provisions for the import or details about the source of waypoint data to be entered into a TCS. In this case the Technical Standard IEC 62065 for Track Control Systems helps for interpretation: Clauses 4c), d) and e) are explicitly stating that such system must comply with the corresponding requirements of an INS. These requirements include the automatic checking of the routes (sequences of waypoints) for known hazards.

A GPS cannot fulfil this requirement within its "general intent" of functions, therefore such combination of TCS with GPS must fully comply with the requirements of an INS (C).

An ECDIS may fulfil this additional requirement, if type approved including the relevant requirements of INS (B) and (C).

It is of course advised that such system combination is completely complying with the requirements of INS (C), to ensure, that both systems use consistent information for planning, control and monitoring, see also B.1.4.

However, a track control system may consist of a heading control system combined with a GPS receiver including its display/control panel. If such complete configuration is type approved as a track control system, the input of waypoints is not a data exchange function between individual equipment and therefore such track control system, by itself, need not additionally comply with INS.

B.2.3 Navigational Aids providing commands to other Navigational Aids

If a Navigational Aid can remotely control functions of another Navigational Aid connected to it, (other than commanding the operational mode or data output of a sensor interface according to IEC 61162), such combination of equipment **must comply with the relevant INS category**. There is no Performance Standard of a Navigational Aid, that includes the remote control of its functions by another Navigational Aid, or vice versa.

Examples for such remote control functions and relevant INS category are:

- selection of sensors, - INS (A)
- selection of the active route, track or next waypoint, - INS (B)
- selection of the display mode, stabilisation mode, or range/scale, - INS (B)
- selection of the mode of control, e.g. the steering mode, - INS (C)

B.2.4 Radar combined with ECDIS **including the transfer of sensor data for position, speed and/or heading**

If an ECDIS is connected to a radar or radar plotting aid for the input of navigation sensor data, i.e. position, speed, and/or heading, this **constitutes an INS (B).** The reason is, that

- the Performance Standard for ECDIS explicitly indicates the connection to "systems", i.e separate sensors, for speed and heading information and for a position fixing system,; and
- the Performance Standard for Radar does not include any function to output other than radar targets to connected navigational aids.

This configuration constitutes an INS (A) if there is no exchange of radar or chart information, otherwise an INS (B), as relevant according to the basic INS functions it provides. (see B.1.4)

The connection of radar and ECDIS only for the data and signals required for the superimposition of the radar image or the display of radar targets, does not constitute an INS. (see B.1.6).

B.2.5 Navigational equipment and combinations to which this International Standard <u>does not</u> apply

There are a number of equipment combinations, for which this International Standard does not apply, namely because the relevant integration functions are already included in their Performance Standards, or do not add functions related to the integrity, consistency or accuracy of navigation information.

Examples:

B.2.5.1 Combination of a radar or an ECDIS with Radar Plotting, EPFS (e.g. GPS), SDME (e.g. EM-Log), Gyro / THD,

A combination of a radar or an ECDIS with RP, EPFS (e.g. GPS), SDME (e.g. EM-Log), and/or THD does not constitute an INS if such combination does not output the sensor data to other navigational aids, because such combinations are covered by the relevant Performance Standards for radar and ECDIS.

B.2.5.2 Combination of a Navigational Aid with only a peripheral output device

A combination of any Navigational Aid with only a peripheral output device, such as a printer, data recorder, remote display or data communication modem*), etc., does not constitute an INS, because a peripheral device is not a Navigational Aid.

*)Typically a modem may be used for reporting the system status to a shore-based office or to support remote fault finding or software maintenance functions, and should be type approved as part of the Navigational Aid. If such data communication modem supports the integration of information from/for other ship-borne equipment, then such combination may constitute an INS or IBS.

However according to SOLAS R.18, 7, a peripheral output device must at least conform to IEC 60945 and IEC 60533.

A Navigational Aid that includes an interface to a peripheral device should at least be type-tested to the extent that the information available at the interface is consistent with the displayed information in a normal operational mode. (See also B.1.7)

B.2.5.3 Combination of a Navigational Aid with other than Navigational Aids or peripheral output devices

The combination of a Navigational Aid with other devices of the ship, e.g. with communication or ship machinery equipment, does not constitute an INS, if such devices are no Navigational Aids. Such combination may however be regarded as an Integrated Bridge System (IBS) and the flag state may require compliance with the respective regulations.

B.2.5.4 A Navigational Aid, e.g. a "Conning Display", that presents information from more than one connected Navigational Aid

The combination of Navigational Aids by a device that presents information from more than one Navigational Aid, is not constituting an INS if it

- only repeats the received information and if it
- does not serve for other functions of the connected Navigational Aids, such as
- exchanging information between them or
- interfacing to sensors.

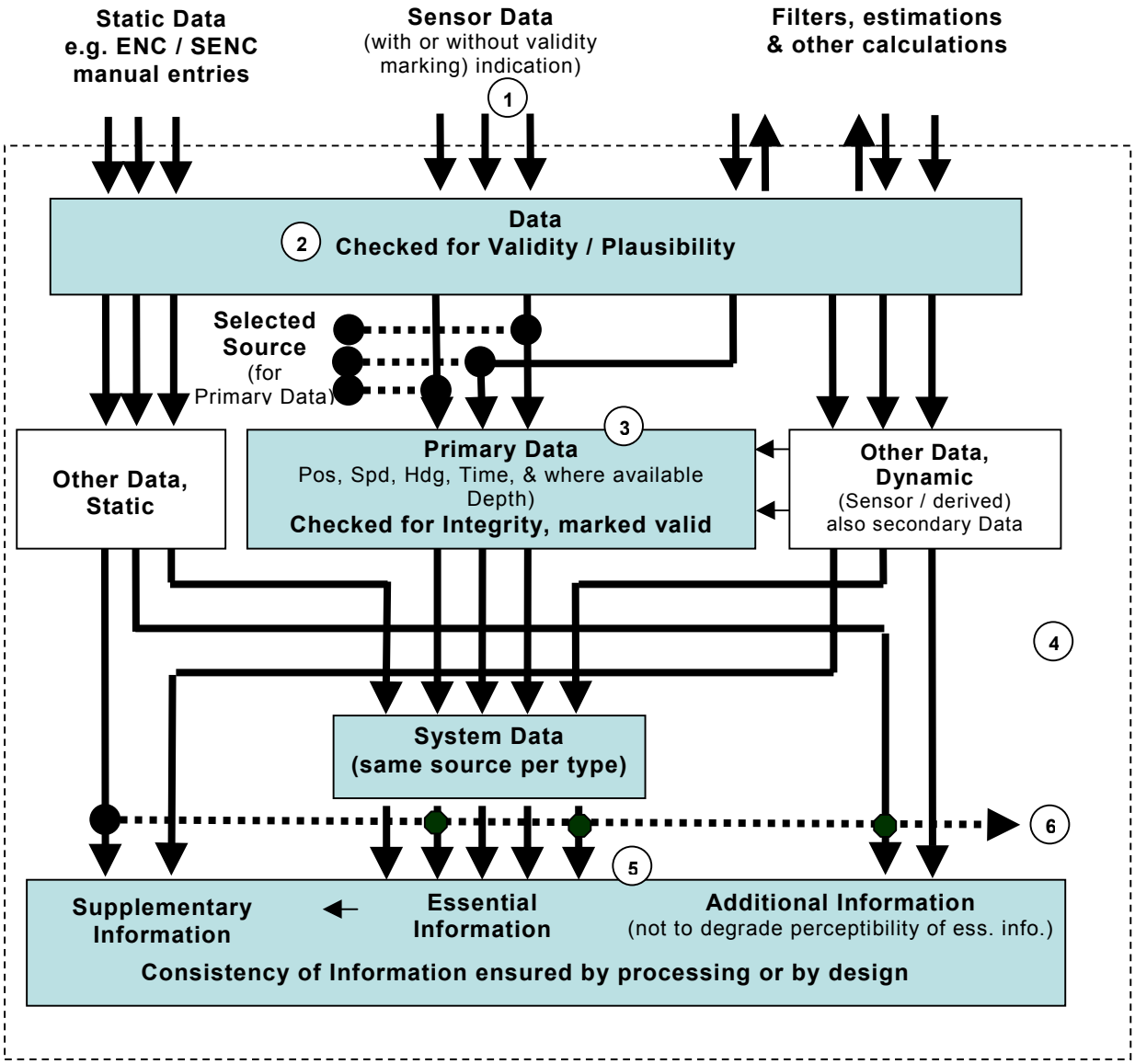
In such case it is regarded as an output peripheral, see B.2.5.b)

Presently there is a gap in the IMO Performance Standards regarding the display of information by equipment for which no specific Performance Standards exist. The IMO has delegated a task to IEC for the recommendation of relevant requirements, for which IEC intends to develop the International Standard IEC 62288, Presentation of navigation related information, which becomes applicable when adopted.

Annex C
(informative)

Data to Information Flow / Consistent Common Reference System (CCRS)

This information attempts to clarify the minimum requirements for data flow through the INS, and how this data is processed as Primary Data, distributed as System Data and finally becomes Information for display or data output. (Colour-filled boxes indicate that processing of data is or may be required)



1) The INS receives **Sensor** data from various sources. The raw data from a sensor may or may not be marked with **Validity**.

2) The information received from Sensors is called **Data**. The information derived from sensor data, e.g. from a filter or from calculations, is also called Data. All Data received or derived from sensors are checked for **Validity**, at least by a **Plausibility** check.

3) The Data from the **Selected Sources** for Position, Speed, Heading and, where available Depth, is **Primary Data.** Note that this is a subset of all Data available to the INS.

4) The **Common Consistent Reference System (CCRS)** processes all input data to determine their Validity, it processes all Primary Data to determine their Integrity, it

provides **System Data** for **Essential Information** to ensure that the same type of data is from the same source, and it ensures **Consistency** of any distributed or displayed information, either by processing (e.g. verifying, centralizing or synchronizing data sources) or by the system design.

5) **Information** is all measured, acquired, computed or manually entered data that is available for **Presentation** (Display) **to an operator**, appropriately complemented with type, source and properties. A subset of Information is **Essential Information** (subset as defined in the relevant section for each INS category)**.**

6) Data that is used for processing, display or **output of essential information** shall be distributed as **system data (SD)**. As a minimum, system data includes position, speed, heading, time and, where available, depth. Interfacing to, and from, the INS shall comply with International Standards, namely IEC 61162 series, as appropriate and applicable.

Annex D
(informative)
Integrity Checks.

D.1 Summary of required integrity checks

4.5.7	Integrity of information to be monitored and verified automatically before …displayed or used Doubtful integrity not to be used for automatic control systems
4.5.8	Integrity of sensor data to be evaluated prior to internal or external distribution
	Integrity to be verified by comparison of data from two or more sources
4.5.8.1	Position data to be checked with - RAIM function of selected sensor, or - Secondary position sensor, or - Independent estimated position
4.5.8.2	Speed data to be checked with - Secondary speed sensor or speed sensing method, or - Speed information from position sensor, or - Speed information derived from position information
4.5.8.3	Heading data to be checked with - Secondary heading sensor (for INS (C))
4.5.8.4	Time data to be checked with - Secondary time source, e.g. time counter
4.5.9.5	Sensors with possible drift errors to be checked - Short term - Long term
4.5.8.6	If checks use STW data - input of set and drift and leeway ??
4.5.9.1 4.5.9.2	Invalid if - Difference between sensor 1 and 2 > 2 x precision of sensor 2, or - Difference between sensor 1 and 2 > 10 x precision of sensor 1(the smaller) Doubtful if- Difference between sensor 1 and 2 > 1 x precision of sensor 2, or - Difference between sensor 1 and 2 > 5 x precision of sensor 1(the smaller) - Long- or short term drift error check was unsuccessful

D.2 Examples for additional or alternative integrity checks (for information, not mandatory)

D.2.1 Position information from the primary EPFS.

#	Method	Equipment required	Method availability	Automatic/ Cognitive	User intervention	INS function (Note)
1	Check position with one from secondary independent EPFS	Extra EPFS receiver.	Within extra EPFS availability	Automatic	Not required	INS shall continuously monitor difference between positions to be within limit set.
2	Check position by Dead Reckoning position (water referenced)	THD/Magnetic Compass Water referenced SDME	Within [a] relatively short period of time due to DR method limitations (drift is not taken into consideration, possible log and THD errors. Good enough to check “jumps”	Automatic	User shall check DR position by other means (e.g. visual fix) as frequently as navigational conditions require (drift, devices accuracy etc).	INS should continuously calculate DR position. INS should continuously monitor difference between positions to be within limit set.
3	Check position by Dead Reckoning position (bottom referenced)	THD/Magnetic Compass Bottom referenced SDME	Same as above with better accuracy, but limited to availability of bottom mode of SDME (e.g. h<200m)	Automatic	Same as above. Drift information will be taken care of.	Same as above
4	Check position by correspondence of objects on radar image and those on chart (electronic chart).	Radar ECDIS (RCDS) OR Radar with selected SENC display	Subject to availability of “radar visible” charted objects (e.g. shore, islands, floating aids to navigation)	Cognitive	User shall check positions of objects on radar image and those on chart (electronic chart).	INS shall provide radar image and chart information within one graphical display. CCRS should be applied.
5	Check position with one calculated from fixed RP (ARPA, EPA, ATA) target (Echo Reference)	ECDIS (if requirement of 4.10.5.6 is achieved by continuous position fix based on plotted target fixed to chart object) RP (ARPA, EPA, ATA). However, interface to EPFS or ER function is required to ensure ground stabilisation not position fix.	Subject to appropriate target availability	Automatic	User shall select reference target(s) and appropriate chart object to start the process. User shall change reference target(s) whenever necessary.	INS should continuously calculate ER position. INS should continuously monitor difference between positions to be within limit set.
6	Check of measured depth information with charted one at current ship’s	ECDIS Echo-sounder	Rather THEORETICAL method	Automatic	Not required (except for draft information input not supported by IEC61162-1 1995)	INS should continuously compare actual depth (measured below transducer and draft) with charted spot sounding at ship’s position. For the purpose INS shall provide tidal prediction. Difference shall be monitored to be within a limit set.

#	Method	Equipment required	Method availability	Automatic/ Cognitive	User intervention	INS function (Note)
	position					
7	Check position by correlation of AIS target and Radar information.	AIS Radar with AIS information display	Limited availability It depends on possible THD errors, range of the target its positioning accuracy etc.	Cognitive	User shall check positions of AIS targets on radar image.	INS shall provide radar image and AIS information within one graphical display. CCRS should be applied.
8	Check position by correlation of AIS target (ship) and corresponding RP target.	AIS RP with AIS information display	Limited availability It depends on possible THD errors, range of the target its positioning accuracy etc.	Automatic	User may be required to make initial correlation manually.	INS shall monitor AIS target and corresponding RP target position difference to be within a limit set.
9	Check position by correlation of AIS fixed target (e.g. lighthouse) and corresponding RP target.	AIS RP with AIS information display	Depends on possible THD errors, range of the target.	Automatic	User may be required to make initial correlation manually.	INS shall monitor AIS target and corresponding RP target position difference to be within a limit set.

D.2.2 Speed through the water from SDME.

#	Method	Equipment required	Method availability	Automatic/ Cognitive	User intervention	INS function (Note)
1	Check speed through the water with SOG from EPFS.	EPFS Tidal current prediction or real time information for OPTIONAL corrections (e.g. within ECDIS).	Use of tidal/seasonal currents prediction improves the accuracy.	Automatic	Not required.	INS shall monitor speed difference to be within a limit set. INS can correct COG/SOG information for predicted or real time tidal/seasonal currents for check purposes.
2	Check speed through the water with ground speed taken by RP echo reference.	RP Tidal current prediction or real time information for OPTIONAL corrections (e.g. within ECDIS).	Subject to availability of appropriate targets. Use of tidal/seasonal currents prediction improves the accuracy.	Automatic	Required for initial reference target selection.	INS shall monitor speed difference to be within a limit set. INS can correct ground speed information for predicted or real time tidal/seasonal currents for check purposes.
3	Check speed through the water with ground speed taken from bottom tracking log.	Bottom log Tidal current prediction or real time information for OPTIONAL corrections (e.g. within ECDIS).	limited to availability of bottom mode of SDME (e.g. h<200m). Use of tidal/seasonal currents prediction improves the accuracy.	Automatic	Not required.	INS shall monitor speed difference to be within a limit set. INS can correct ground speed information for predicted or real time tidal/seasonal currents for check purposes.

D.2.3 Heading from THD.

#	Method	Equipment required	Method availability	Automatic/ Cognitive	User intervention	INS function (Note)
1	Check heading with magnetic heading corrected by magnetic variation and deviation. OR with the heading from the second THD.	TMHD Magnetic variation database or extra THD	Not limited. Accuracy is lower on manoeuvres.	Automatic	Not required.	INS shall monitor difference in THD reading and magnetic compass reading (the latter should be corrected for deviation and magnetic variation).
2	Check heading with COG from EPFS	EPFS	Method gives reasonably good results on relatively high speed and steady courses. Availability of current and drift due to wind may considerably affect method accuracy.	Automatic	Not required.	INS shall monitor difference in THD reading and COG from EPFS.
3	Check heading with the one from EPFS	EPFS capable to determine ship's hull orientation (heading)	Not limited.	Automatic	Not required.	INS shall monitor difference between THD heading and heading from EPFS.
4	Check heading by correspondence of objects on radar image and those on chart (electronic chart).	Radar ECDIS (RCDS) OR Radar with selected SENC display	Subject to availability of "radar visible" charted objects (e.g. shore, islands, floating aids to navigation)	Cognitive	User shall verify heading by visible bearing offset of objects on radar image and those on chart (electronic chart). In case of heading error all objects should have more or less same bearing offset, so, that radar picture "rotated" over the chart.	INS shall provide radar image and chart information within one graphical display. CCRS should be applied.
5	Check heading by correspondence of objects tracked by RP and those on chart (electronic chart).	ECDIS interfaced to RP or RP with SENC information	Subject to appropriate target availability	Automatic	May be required for initial association of charted object(s) and RP target(s).	INS shall monitor bearing difference of associated objects to be within a limit set.
6	Check heading by correspondence of objects on radar image and those	AIS interfaced to Radar.	Subject to availability of AIS targets.	Cognitive	User shall verify heading by visible bearing offset of objects on radar image and AIS targets. All	INS shall provide radar image and AIS information within one graphical display. CCRS should be applied.

#	Method	Equipment required	Method availability	Automatic/ Cognitive	User intervention	INS function (Note)
	received from AIS.				objects should have more or less same bearing offset, so, that radar picture “rotated” over the AIS information.	
7	Check heading by correspondence of objects tracked by RP and those received from AIS.	AIS interfaced to RP.	Subject to availability of AIS targets.	Automatic	May be required for initial association of AIS target(s) and RP target(s).	INS shall monitor bearing difference of associated targets to be within a limit set.

Annex E
(informative)
Example of a failure analysis (to be developed)

Annex F
(informative)
Table of display requirements

INS (A) (B) +(C)		INS (B) + (C)		INS (C)	
4.8.3	Available for continuous display Ownship geographic position, which shall be displayed as WGS84 (N/S - E/W), Speed through the water or over the ground, True heading, Time (UTC or local), Depth of water under keel, 1), System status, Display mode (where not distinctively obvious), Mode of operation (where not distinctively obvious).	6.5.1	Available for continuous display Geographical display as per 6.1.1including the own ship's symbol and required display controls (radar, chart, targets); The active route (within the display area); with designation, including waypoints and their straight or curved connections with course, radius, ROT and speed values as planned, with the actual leg specifically marked as planned Control and display of scale or range, and orientation; Planned (if relevant) and actual course over ground; Off course deviation and off track distance if an active route is selected; Panned (if relevant) and actual speed over ground and /or speed through water with drift angle, (the speed that is used for stabilisation of target vectors shall (additionally) be displayed).	7.4.1	Available for continuous display the active mode of steering or speed control time and distance to wheel-over, at least after the relevant limit for early course change indication has been reached set and actual radius or rate of turn to the next segment, if the route includes a curved segment or in case of a track control system of category B rudder angle, propulsion data - e.g. power, propeller pitch, as relevant
4.8.4 4.8.8 4.10 4.12.2	Event-related display Alarms and warning indications; Changes of system status; Automatic changes of display or operational modes; Automatic change of the available system configuration. **Display on demand** Display of sensor output data Configuration display Alarms/Indications and related messages List of alarms and messages	6.5.2	Display on demand Designation of the selected route, including designations of the "from" and "to" waypoints; Graphical indication of the track limits at the geographic presentation of the actual leg (at least in a display range or scale where the availability of a scaled ship's symbol is required); Time and distance to wheel-over; Planned and actual radius or rate of turn for the turn to the NEXT-leg; Planned course and speed for the NEXT-leg.	7.4.3	Display on demand user settable limits and pre-set control parameters related to automatic control functions

Annex G
(informative)
Table of Alarms and Warnings
to be developed

Annex H
(informative)
IMO Safety of Navigation Circular No 217

INTERIM GUIDELINES FOR THE PRESENTATION AND DISPLAY OF AIS TARGET INFORMATION

1 The Sub-Committee on Safety of Navigation (NAV), at its forty-seventh session (2 to 6 July 2001), agreed on interim guidelines for the presentation and display of AIS target information.

2 The interim guidelines deal with the graphical presentation and display of AIS target data in standalone or integrated navigational aids or systems and are considered as an interim performance guideline. They should be replaced by the appropriate performance standards after experience has been gained.

3 These interim guidelines have been established to allow manufacturers to develop the relevant equipment and functions in time and to allow mariners to acquaint themselves with the use of intelligent combination of information from the first date of AIS deployment.

4 Member Governments are invited to bring the annexed interim guidelines to the attention of all concerned.

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INTERIM GUIDELINES FOR THE PRESENTATION AND DISPLAY OF AIS TARGET INFORMATION

1 Definitions

Sleeping target A target symbol indicating the presence and orientation of a vessel equipped with AIS in a certain location. No additional information is presented until activated thus avoiding information overload.

Activated target A symbol representing the automatic or manual activation of a sleeping target for the display of additional graphically presented information including:
- a vector (speed and course over ground);
- the heading; and
- ROT or direction of turn indication (if available) to display actually initiated course changes.

Selected target A symbol representing the manual selection of any AIS target for the display of detailed information in a separate data display area. In this area, received target data as well as the calculated CPA and TCPA values will be shown.

Dangerous target A symbol representing an AIS target (activated or not) which data contravene pre-set CPA and/or TCPA limits.

Lost target A symbol representing the last valid position of an AIS target before the reception of its data was lost.

2 Operational requirements

In addition to the relevant performance standards, AIS information may be presented and displayed according to the following interim guidelines.

2.1 Presentation of information

2.1.1 If AIS information is made available for a graphical display, at least the following information should be displayed: (see resolution MSC.74(69), Annex 3 (AIS), paragraph 6):

.1 position;

.2 course over ground;

.3 speed over ground;

.4 heading; and

.5 rate of turn, or direction of turn, as available.

2.1.2 If information provided by AIS is graphically presented, the symbols described in the Appendix should be applied. In the case of a radar display, radar signals should not be masked, obscured or degraded.

2.1.3 Whenever the graphical display of AIS targets is enabled, the graphical properties of other target vectors should be equivalent to those of the AIS target symbols, otherwise the type of vector presentation, (radar plotting symbols or AIS symbols), may be selectable by the operator. The active display mode should be indicated.

2.1.4 The presentation of AIS target symbols, except for sleeping or lost targets, should have priority over other target presentations within the display area, including targets from EPA, ATA or ARPA. If such a target is marked for data display, the existence of the other source of target data may be indicated, and the related data may be available for display upon operator command.

2.1.5 The mariner should be able to select additional parts of the information from AIS targets, which should then be presented in the data area of the display, including the ship's identification, at least the MMSI. If the received AIS information is not complete, this should be indicated.

2.1.6 A common reference should be used for the superimposition of AIS symbols with other information on the same display, and for the calculation of target properties (e.g. TCPA, CPA.).

2.1.7 If AIS information is graphically displayed on a radar, the equipment should be capable of appropriately stabilising the radar image and the AIS information.

2.1.8 Target data derived from radar and AIS should be clearly distinguishable as such.

2.1.9 The operator may choose to display all or any AIS targets for graphical presentation. The mode of presentation should be indicated.

2.1.10 If the display of AIS symbols is enabled, removing a dangerous target should only be possible temporarily as long as the operator activates the corresponding control.

2.1.11 The AIS symbol of an activated target may be replaced by a scaled ship symbol on a large scale/small range display.

2.1.12 If the COG/SOG vector is shown, its reference point should be either the actual or the virtual position of the antenna.

2.1.13 Means should be provided to select a target or own ship for the display of its AIS data on request. If more than one target is selected, the relevant symbols and the corresponding data should be clearly identified. The source of the data, e.g., AIS, radar, should be clearly indicated.

2.2 Processing of information

2.2.1 If zones or limits for automatic target acquisition are set, these should be the same for automatically activating and presenting any targets regardless of their source.

2.2.2 The vector time set should be adjustable and valid for presentation of any target regardless of its source.

2.2.3 If radar plotting aids are used for the display of AIS information, these should be capable of calculating and displaying collision parameters equivalent to the available radar plotting functions.

2.2.4 If the calculated CPA and TCPA values of an AIS target are less than the set limits,

- a dangerous target symbol should be displayed; and

- an alarm should be given.

The preset CPA/TCPA limits applied to target data derived from different sensors should be identical.

2.2.5 If the signal of a dangerous AIS target is not received for a set time:

- a lost target symbol should appear at the latest position and an alarm be given;

- the lost target symbol should disappear after the alarm has been acknowledged; and

- means to recover the data for a number of last acknowledged lost targets may be provided.

Preferably this function may also be applied to any AIS target within a certain distance.

2.2.6 An automatic display selection function may be provided to avoid the presentation of two target symbols for the same physical target. If target data from AIS and from radar plotting functions are available, then the activated AIS target symbol should be presented, if the automatic selection criteria is fulfilled, otherwise the respective symbols should be displayed separately. The operator

should have the option to make reasonable changes to the default parameters of automatic selection criteria.

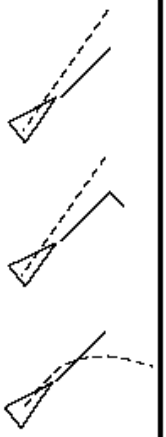
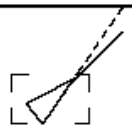
2.2.7 Means should be provided to display and acknowledge alarm messages from own AIS. Indication should be given if own AIS is out of service or switched off.

2.3 Human Interface

As far as practical, the user interface for operating, displaying and indicating AIS functions should be equivalent to the other relevant functions of the navigational aid.

Appendix

Recommended AIS Target Symbols

AIS target	Symbol	Description of symbol
AIS target (sleeping)		An isosceles, acute-angled triangle should be used with its centroid representing the target's reference position. The most acute apex of the triangle should be aligned with the heading of the target, or with its COG, if heading information is not available. The symbol of the sleeping target may be smaller than that of the activated target.
Activated AIS target		An isosceles, acute-angled triangle should be used with its centroid representing the target's reference position. The most acute apex of the triangle should be aligned with the heading of the target, or with its COG, if heading information is not available. The COG/SOG vector should be displayed as dashed line starting at the centroid of the triangle The heading should be displayed as solid line of fixed length starting at the apex of the triangle A flag on the heading indicates a turn and its direction in order to detect a target manoeuvre without delay A path predictor may also be provided
Selected target		A square indicated by its corners should be drawn around the target symbol.
Dangerous target		A bold line clearly distinguishable from the standard lines should be used to draw the symbol. The size of the symbol may be increased. The target should be displayed with: vector, heading and rate of turn indication. The symbol should flash until acknowledged. The triangle should be red on colour displays.
Lost target		A prominent solid line across the symbol, perpendicular to the last orientation of the symbol should be used. The symbol should flash until acknowledged. The target should be displayed without vector, heading and rate of turn indication.

– If colour fill is used no other information should be masked or obscured.

– Base stations may transmit information on targets tracked by other means. If these targets are displayed they should be presented using symbols clearly distinguishable from the symbols above.

– Further symbology for special situations will be developed.

Annex I
(informative)
Cross-reference between requirements and tests

to be developed

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